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ANN ARBOR, MICH. U. S. A.

Volume 19 JULY, 1945 Number 4

JOURNAL OF PALEONTOLOGY

A publication of The Society of Economic Paleontologists and Mineralogists *and* The Paleontological Society *with the generous support and cooperation of* The American Association of Petroleum Geologists *and* The Geological Society of America

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The Journal of Paleontology is published bi-monthly. The numbers issued in January, May, and September are sponsored by The Paleontological Society in cooperation with The Geological Society of America; those issued in March, July, and November are sponsored by The Society of Economic Paleontologists and Mineralogists in cooperation with The American Association of Petroleum Geologists.

The subscription price of the Journal of Paleontology is $6.00 per year prepaid to addresses in the United States.

Single numbers, $2.00 each.

Postage is charged extra for all other countries in the Postal Union, 40 cents on annual subscriptions (total $6.40).

The Journal will furnish reprints at cost. Orders should accompany manuscript.

Communications about the Journal, subscriptions, rates, memberships, change of address, and nonreceipt of preceding numbers should be addressed to Society of Economic Paleontologists and Mineralogists, P. O. Box 979, Tulsa 1, Oklahoma. Claims for nonreceipt of preceding numbers must be sent in within three months of the date of publication in order to be filled gratis. Communications in regard to advertising should be addressed to J. Marvin Weller, Illinois Geological Survey, Urbana, Ill.

Communications in regard to manuscripts or purely editorial matters should be addressed to J. Marvin Weller, Illinois Geological Survey, Urbana, Ill., or to C. Wythe Cooke, U. S. National Museum, Washington, D.C.

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Entered as second-class matter at the Post Office at Tulsa 1, Oklahoma, under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in paragraph 4, section 538, P. L. and R., authorized April 3, 1935.

Additional entry as second-class matter at the Post Office at Menasha, Wis.

GEORGE BANTA PUBLISHING COMPANY, MENASHA, WIS.

JOURNAL OF PALEONTOLOGY

A publication of THE SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS *and* THE PALEONTOLOGICAL SOCIETY *with the generous support and cooperation of* THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS *and* THE GEOLOGICAL SOCIETY OF AMERICA

VOLUME 19 | JULY, 1945 | NUMBER 4

SOME NEW GENERA OF THE BELLEROPHONTACEA[1]

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U. S. National Museum, Washington, D. C.

ABSTRACT.—Seven new genera and three new species of the Bellerophontacea are erected. Two genera are referred to the family Sinuitidae; *Sinuitina*, genotype *Tropidocyclus cordiformis* Newell; and *Crenistriella*, genotype *Bellerophon crenistria* Hall. Five genera are referred to the family Bellerophontidae; *Sphenosphaera*, genotype *Bellerophon clausus* Ulrich in Ulrich and Scofield, *Liljevallospira*, genotype *Bellerophon tubulosus* Lindström; *Retispira*, genotype *R. bellireticulata* Knight, new species; *Patellilabia*, genotype *P. tentoriolum* Knight, new species; and *Phragmosphaera*, genotype *P. miranda* Knight, new species.

IN WORKING on the Bellerophontacea in the collections of Paleozoic Gastropoda at the U. S. National Museum it became apparent that a partial reclassification of this interesting group of early gastropods is desirable. In order to make this reclassification as complete as possible certain new genera are needed. It seems best to validate the names of these genera at the earliest opportunity to avoid labelling specimens in the Museum collections with invalid, unpublished names. This is the purpose of the present paper. A more extensive discussion of the taxonomic revisions and the reasons for them is planned for publication in the future.

Superfamily BELLEROPHONTACEA
Family SINUITIDAE
Genus SINUITINA Knight, n. gen.

Bellerophon (in part) of earlier authors.
Tropidocyclus (in part) of Koninck, 1882 (p. 81) and 1883 (p. 160); Clarke 1899 (p. 72) and of Clarke, 1904 (p. 330); Weir, 1931 (p. 836); Newell, 1935 (p. 349).
Bucanella (in part) of Knight, in Shimer and Shrock, 1944 (p. 441).

Genotype, *Tropidocyclus cordiformis* Newell, 1935 (p. 349).

Diagnosis: Bellerophontiform gastropods with cordiform whorl-section, open umbilici and somewhat narrow U-shaped sinus in anterior lip; without true slit or selenizone, but with ill-defined pseudoselenizone; flange-like circum-umbilical carina in genotype and some other species; inductura thin, unornamented; ornamentation predominately transverse, consisting of somewhat sharp lirae in most species.

Comparisons: *Sinuitina* is distinguished from its closest relative, *Bucanella* Meek, 1871, by its cordiform or even lanceolate whorl-section as contrasted with the trilobed, cloverleaf-like whorl-section of that genus and, perhaps, by the circum-umbilical carina. *Tropidodiscus* Meek and Worthen, 1866 (=*Tropidocyclus* Koninck, 1882, and *Oxydiscus* Koken, 1889) usually has a more lanceolate whorl-section and, moreover, a

[1] Published with the permission of the Secretary of the Smithsonian Institution.

true slit of some depth that generates a narrow selenizone (Knight, 1941, p. 362).

Range: Devonian—Pennsylvanian.

Genus CRENISTRIELLA Knight, n. gen.

Bellerophon (in part) of Hall, 1879 (p. 94).

Genotype, *Bellerophon crenistria* Hall, 1877 (expl. pl. 25).

Diagnosis: Bellerophontiform gastropods with shape and broad U-shaped anterior sinus much as in *Sinuites* Koken, 1896; surface ornamentation of fine crenulated lirae or nodes commonly arranged more or less in quincunx; seemingly no inductural ornamentation; columellar lips apparently slightly reflexed and thickened; without true slit or selenizone.

Comparisons: *Crenistriella* is differentiated from *Sinuites* by its conspicuously ornamental sculpture and its seemingly reflected columellar lips. In *Sinuites* a part of the ornamentation is developed on an inductural layer extending outside of the aperture very much as in *Euphemites* Warthin, 1930. The ornamentation of *Crenistriella* is not only different in character but it is not developed on an inductural layer, as far as can be seen on the specimens.

Range: *Crenistriella* is represented by a single species of mid-Devonian age.

Family BELLEROPHONTIDAE

Genus SPHENOSPHAERA Knight, n. gen.

Bellerophon (in part) of Ulrich and Scofield, 1897 (p. 914).

Genotype, *Bellerophon clausus* Ulrich in Ulrich and Scofield, 1897 (p. 916).

Diagnosis: Bellerophontiform gastropods with more or less rapidly expanding whorls and somewhat wedge-shaped outline as seen from above; lateral lips flaring moderately with posterior and columellar lips, in conjunction, broad and often concave on apertural face; breadth of lips resulting in part from slight backward flare but principally from tendency to develop forward in plane of aperture forming incipient apertual plate similar in character, but not in degree of development, to that of *Carinaropsis* Hall, 1847 (=*Phragmostoma* Hall, 1861); well marked ridge very similar to and entirely homologous with that in *Carinaropsis* and in the Ordovician genotype of *Bucanopsis* Ulrich in Ulrich and Scofield, 1897, on floor of whorl within spire; ornamentation of only transverse elements, usually growth lines; shallow slit producing a selenizone.

Comparisons: *Sphenosphaera* is erected to include, amongst others, those Ordovician species referred to *Bellerophon* Montfort, 1808, by Ulrich and Scofield. These species appear to be linked, by the peculiarities of their posterior lip and by the ridge on the floor of the interior of the whorl, more closely to the contemporary *Bucanopsis* and *Carinaropsis* than they are to *Bellerophon*. *Sphenosphaera* is differentiated from *Bellerophon* by the above-mentioned apertual characters, from *Carinaropsis* by the incipient stage of development of the apertual plate and by its less reduced spire, and from *Bucanopsis* and *Phragmosphaera* (new) by its lack of revolving ornamentation.

Range: Ordovician—Silurian?

Genus LILJEVALLOSPIRA Knight, n. gen.

Bellerophon (in part) of Lindström, 1884 (p. 72).

Genotype: *Bellerophon tubulosus* Lindström, 1884 (p. 77).

Diagnosis: Bellerophontiform gastropods with true columellar lips enclosed on each side by backward extensions of lateral lips in such manner that what might be called a second columellar lip is developed behind each of the true lips with an open space between them; open spaces becoming tubes on growth of shell, closed or almost closed on sides, revolving about umbilical region with openings at apertural ends behind true columellar lips and true apertual opening but still within embrace of shell; apertural lips flaring little, if at all; parietal inductura thin; short slit producing a selenizone; ornamentation predominately transverse but revolving elements also present in some species.

Comparison and discussion: This genus is proposed for two remarkable species *Bellerophon tubulosus* Lindström and *B. elegantulus* Lindström. I have not handled specimens of either species but have studied Lindström's descriptions and illustrations. The beautiful drawings in Lindström's work by that incomparable illustrator G. Liljevall, naturalist as well as artist, are highly accurate and reliable and hence I venture to erect a genus for these two peculiar species even though I have handled no specimens.

The circum-umbilical tubes developed in species of this genus serve to distinguish it from all other Bellerophontid genera.

Range: Silurian.

Genus RETISPIRA Knight, n. gen.

Bellerophon (in part) of earlier authors.
Euphemus (in part) of M'Coy, 1844 (p. 25).
Bucania (in part) of many authors.
Bucanopsis (in part) of Ulrich in Ulrich and Scofield in 1897 (p. 853), and of most authors writing since the erection of that genus.

Genotype, *Retispira bellireticulata* Knight, new species.

Diagnosis: Bellerophontiform gastropods with revolving ornamentation but without strongly expanded aperture, sharply defined ridge on floor of interior of whorl, or plate-like extension of inner lip into aperture; posterior lip a thin, or only moderately thickened, unornamented inductura; anterior slit short, generating a well-marked selenizone, the selenizone raised, depressed or flush with shell surface, usually with sharp lunulae; umbilici preponderately open, usually narrow; ornamentation always including revolving lirae of one or more orders, and transverse elements which may be growth lines, transverse lirae, or even transverse undulations.

Comparisons and Discussion: In respect to the character of the ornamentation there are species of *Retispira* [e.g. *R. tenuilineata* (Gurley)] with dominant revolving ornamentation and only faint transverse growth lines, which converge in this respect with *Patellilabia* (new), but which are to be differentiated from that genus by their unexpanded apertures. Other species intergrading with these, have the revolving and transverse elements of approximately equal strength [e.g. *R. bellireticulata*, the genotype, and *R. textiliformis* (Gurley)]. Still others, intergrading with the latter, [e.g. *R. nodocostata* (Gurley)] show transverse undulations, and these, in turn, intergrade, in respect to this feature with *Cymatospira* Knight (1942, p. 487). They are to be distinguished from that genus by their unexpanded apertures. An attempt was made to differentiate these three seemingly different lines within *Retispira* but without success. The integradation seems too complete. Indeed, to carry the picture further, *Patellabia* and *Cymatospira*, although at the opposite ends of a series intergrading in ornamentation, are convergent at least in respect to their widely expanded apertures and the strongly projecting, tooth-like thickening of the parietal inductura of some species. Another line, represented by *Knightites* Moore, 1941, differs from *Cymatospira* chiefly in that the somewhat nodelike projections of the saliant undulations that border the midline on each side in *Cymatospira* are developed into tube-like canals at late ephebic stages (Moore, 1941, p. 149, et. seq.). This is a truely fascinating and perplexing series!

Retispira is to be distinguished from *Bucanopsis* by its simple, inducturnal inner lip and its lack of the sharp ridge on the floor of the interior of the whorl, which feature links the latter somewhat closely with *Sphenosphaera* and *Carinaropsis*. It is to be distinguished from *Bellerophon* by its revolving lirae.

Range: Devonian—Permian.

RETISPIRA BELLIRETICULATA Knight, n. sp.
Plate 49, figures 1a–c

Description: Small bellerophontiform gastropods with characteristic revolving lirae of *Retispira* strongly developed and forming beautiful reticulate pattern with almost as strongly developed and evenly spaced transverse lirae; whorl profile broadly rounded on dorsum, more sharply rounded as it turns into umbilici; deeply involute, with narrow umbilici; aperture seemingly flaring little at sides; columellar lips moderately thickened, with lobe-like extensions on inner ends reflected around umbilici; anterior lip very slightly convex forward on each side of selenizone, swinging gently backward close to selenizone to form shallow sinus culminating in slit about $\frac{1}{8}$ revolution in depth; selenizone rather wide, convex; parietal inductura thin or even wanting on easily visible median part of previous whorl although present close to columellar lips; surface ornamented by network of rather strong revolving lirae and somewhat weaker transverse lirae with small nodes at intersections, revolving lirae increasing in number by intercalation as growth proceeds; selenizone ornamented by somewhat stronger imbricating transverse lirae forming lunulae

and weaker revolving lirae that appear not to cross lunulae; shell moderately thick, structure unknown.

Dimensions, with allowance for breakage:

	Diameter	Greatest width
Holotype, Princeton University Coll. No. B254	9.6 mm.	10.2 mm.
F. B. Plummer Coll. No. P-11116	8.5 mm.	8.4 mm.
Texas Bureau of Economic Geology Coll. No. 11152	12.6 mm.	10.5 mm.
	10.4 mm.	10.1 mm.

Remarks: All of the fourteen specimens before me are from shale and their surface features are preserved in great detail. The actual slit has been observed only in the holotype where it may be seen in the mashed part of the anterior lip.

Comparisons: This species resembles rather closely *R. bella* (Keyes) 1894 (p. 148, pl. 50, fig. 7) as illustrated by Keyes and specimens were so labeled in a prelininary identification at the Texas Bureau of Economic Geology. However, Keyes' brief description is inadequate for identification and his illustration, a rather rough drawing, is not entirely trustworthy. *R. bella* furthermore appears to be identical with *R. textiliformis* (Gurley), 1883, as suggested by Sayre (1930, p. 129), and its name, therefore, is a junior synonym. Sayre's figures of the same species (Sayre, 1930, pl. 13, figs. 4, 4a, 5), although photographic, are very unsatisfactory and it seems more profitable to employ Weller's republication of Gurley's description with adequate figures of metatype material (Weller, 1929, p. 315, pl. 1, figs. 7a, 7b, 8) rather than Keyes'. From these descriptions and figures it may be seen that *R. bellireticulata* differs from *R. textiliformis* in its smaller size, less globular form, relatively stronger revolving lirae and the thinness (or even absence) of its parietal inductura.

Hypodigm.: Fourteen specimens as listed below.

Occurrence: Princeton collection—B253 (Holotype), B254, B255, B256 (one specimen each), B257 (4 specimens) and University of Texas, Bureau of Economic Geology collection—nos. 11152, 11215, and Plummer collection—nos. P-11116 and P-11216 (one specimen each) are all from the *Gastrioceras smithwickense* zone of the Smithwick shale at Bureau of Economic Geology Loc. 55-T-43; Princeton collection—B258 (one specimen) is from the same zone at Bureau of Economic Geology Loc. 153-T-6. Plummer collection No. P-10556 (one specimen) is from the *Cumminsia* zone of the Smithwick shale at Bureau of Economic Geology Loc. 205-T-13. The Smithwick shale is here regarded as a formation of early Pennsylvanian age at the top of the Bend group of Texas.

Genus PATELLILABIA Knight, n. gen.

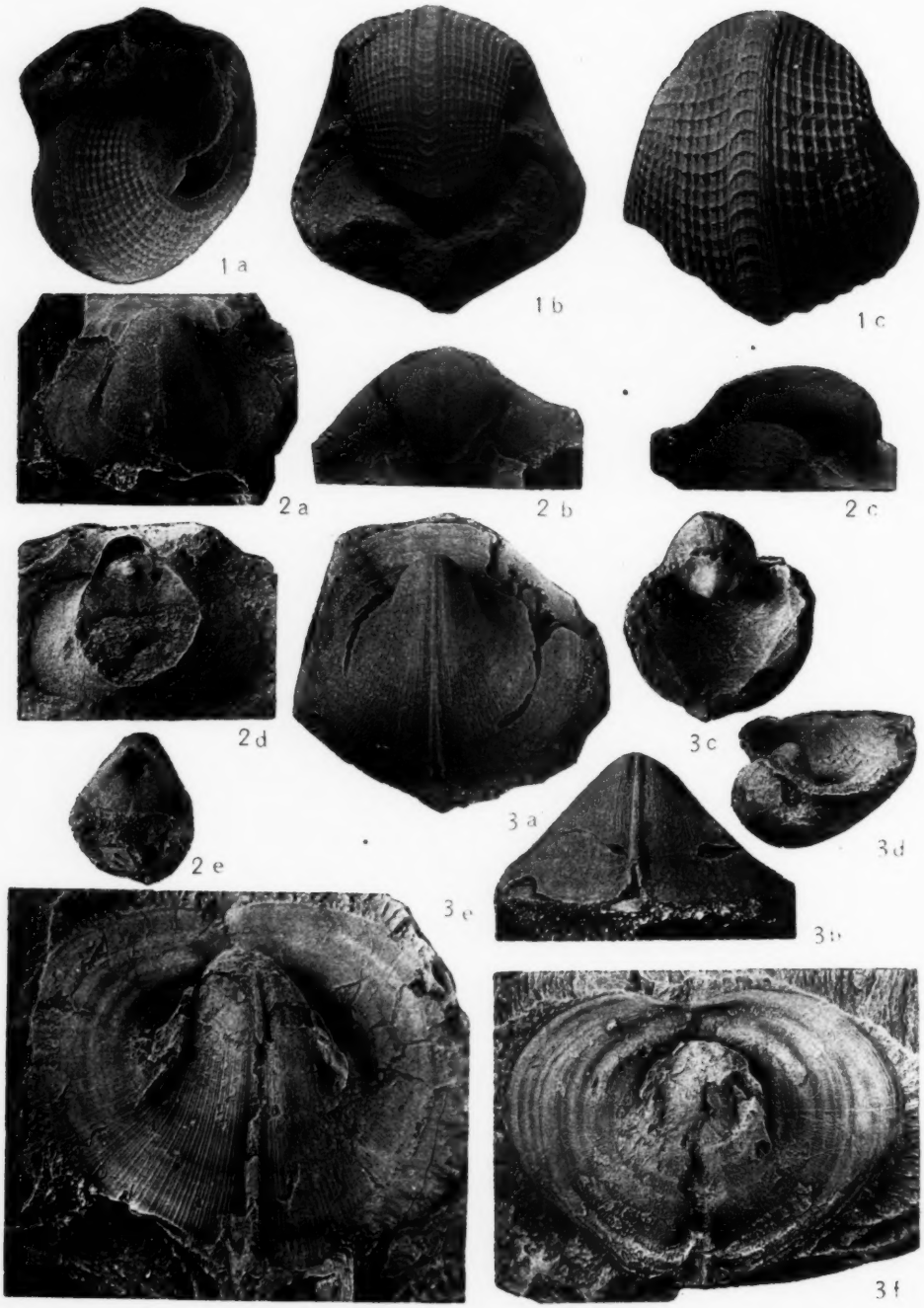
Bellerophon (in part) of older authors
Patellostium (in part) of Sayre (1930, p. 128)

Genotype, *Patellilabia tentoriolum* Knight, new species.

Diagnosis: Bellerophontiform gastropods with revolving ornamentation and expanded apertures but without strong transverse undulations or plate-like extension of inner lip into aperture; lip expanded anteriorly, laterally or posteriorly; parietal inductura thin or thickened to knob-like projection within the aperture; anterior slit short, producing narrow selenizone; ornamented dominantly by revolving lirae; transverse ornamentation, if developed at all, of growth lines and in some species transverse lirae on earlier whorls alone.

Comparisons: The genus is differentiated from *Retispira* by its expanded aperture, from *Phragmasphaera* (new) by its lack of a plate-like extension of the inner lip into the aperture and from *Cymatospira* by its lack of strong transverse undulations. I do not compare it with *Patellostium* Waagen, 1880 (p. 131) because the genotype of *Patellostium* is based on such very poor specimens that its characters are not sufficiently well known to permit the genus to be recognized (Knight, 1941, p. 236). It is my opinion that *Patellostium* is more like *Ptomatis* Clarke, 1899, than any other genus known to me, although I cannot be certain that they are identical. Waagen, according to his diagnosis of *Patellostium*, undoubtedly would have included in his genus the forms I include in *Patellilabia*.

Range: Mid-Devonian—Pennsylvanian.



Knight—Bellerophontacea

PATELLILABIA TENTORIOLUM Knight, n. sp.
Plate 49, figures 3a–f

Bellerophon marcouianus Geinitz, Keyes 1894 (p. 148).
Patellostium marcouianum (Geinitz), Sayre 1930, (p. 128) not *Bellerophon marcouianus* Geinitz, 1866 (p. 7).

Description: Bellerophontiform gastropods with revolving lirae, rather rapidly expanding whorls and apertural lip expanded widely at sides and in back; whorl profile as seen from in front rather narrowly rounded on dorsum, sloping away from dorsum on each side at angle of about 45°, with very slight concavity to margins of expanded lip, the whole suggesting a tent with rounded apex; two slight sulci close to dorsum formed by corresponding grooves on each side of narrow slightly raised selenizone; narrowly phaneromphalous; aperture flaring little or not at all anteriorly, markedly flared at the sides and strikingly so in back where flare reaches considerably beyond coiled spire; expanded aperture appears subcircular from above or below, wider behind midline than in front; posterior lip with sharply rounded protruding inductural thickening just within aperture; subcircular margins of lip with obscure, shallow sinus behind spire and narrow, sharp sinus in middle of anterior lip; anterior sinus culminating in short slit, about $\frac{1}{8}$ whorl revolution in depth, producing slightly raised, arched selenizone; surface ornamentation including that of the selenizone, consisting of numerous (over 100) revolving lirae increasing in number toward aperture, intercalated lirae rapidly approximating others in size so that there is little basis for discrimination of more than one, or at the most two, orders of lirae; transverse ornamentation of irregularly spaced incremental lines over more mature parts of shell but with more regularly spaced lines or transverse lirae on earlier parts; shell rather thin, structure unknown.

Remarks: Two of the four specimens before me are excellently preserved in oolitic limestone and two are mashed shells in a soft clay shale. The holotype, one of the former, shows the external form and ornamentation

Dimensions:	Width across aperture	Length across aperture	Height above apertural plane
Holotype (U. S. N. M. 33175)	42 mm.	36.5 mm.	16.2 mm.
Largest paratype (U. S. N. M. 99079)	63 mm.	49.6 mm.	[a]

[a] Unmeasurable because of mashing from above.

EXPLANATION OF PLATE 49

FIGS. *1a–c—Retispira bellireticulata* Knight, n. sp. *a*, Holotype, ×4 (Princeton B253). Oblique apertural view. *b*, Paratype, ×5 (Princeton B254). Apertural view. *c*, Paratype, ×5 (Princeton B255). Somewhat oblique dorsal view. (p. 335)

2a–e—Phragmosphaera miranda Knight, n. sp. *a*, Holotype, ×1 (U. S. N. M. 90342) unmashed internal filling. Dorsal view. *b*, Holotype, ×1. Posterior view. Note sutures of apertural diaphragm on each side of spire. *c*, Holotype, ×1. Somewhat oblique side view to show left suture of diaphragm. *e*, Paratype, ×1 (U. S. N. M. 111756) internal filling in shale somewhat mashed and flattened. Viewed from above. Dorsal part broken away exposing impression of outer side of diaphragm. Small rounded projection near top is the small coiled spire. *f*, Dorsal part of filling of same paratype viewed from apertural side showing impression of inner side of diaphragm. There is no median ridge as in *Carinaropsis*. Small rounded depression near top is counterpart of projection in the foregoing figure. (p. 338)

3a–f—Patellilabia tentoriolum Knight, n. sp. *a*, Holotype, ×1 (U. S. N. M. 33175). Dorsal view. *b*, Holotype, ×1. Anterior view. *c–d*, Two views of paratype, ×1 (U. S. N. M. 48150). Flaring lips of aperture broken away, knob-like thickening of parietal inductura exposed by preparation. *e–f*, Two paratypes, ×1 (U. S. N. M. 99079) both strongly mashed in shale but show outlines of expanded apertural margins clearly. These specimens are thought to be more fully mature than holotype. Emargination in posterior lip seems to have developed at very latest growth-stage only. (p. 337)

I am indebted to Dr. G. Arthur Cooper of the U. S. National Museum for the photographs of the specimens of the last two species.

beautifully and the other limestone specimen (U. S. N. M. 48150) is broken in such a way that the heavy, protruding inductural knob could be exposed by preparation. The clay shale specimens show the outlines of the expanded lip in great perfection.

Comparison: *P. tentoriolum* is distinguishable from species of *Cymatospira*, which also have a conspicuously expanded lip and, on some species, a protruding inductural knob, by its lack of the regular transverse undulations that characterize all species of the latter genus. There are other species of *Patellilabia* in the American Pennsylvanian but they are undescribed.

Hypodigm.: The four specimens listed below.

Occurrence: The holotype (U. S. N. M. 33175) from the Westerville oolite of the Kansas City group, Pennsylvanian, at Kansas City, Missouri; one specimen (U. S. N. M. 48150) from the Westerville oolite at Turner, Kansas; two specimens (U. S. N. M. 99079) from a soft, blue-gray, clay shale of the Kansas City group at Kansas City, Missouri, which, according to Prof. Raymond C. Moore, who is intimately familiar with the Kansas City section and who has examined the specimens, is undoubtedly the Lane shale.

Genus PHRAGMOSPHAERA Knight, n. gen.

Bellerophon (in part) of Hall, 1861 (p. 31) and 1879 (p. 94).
Bucanopsis (in part) of Ulrich and Scofield, 1897 (p. 853).
Phragmostoma of Clarke, 1904 (p. 322), not of Hall, 1861.
Carinaropsis (in part) of Clarke, 1904 (p. 323, 427).

Genotype, *Phragmosphaera miranda* Knight, new species.

Diagnosis: Bellerophontiform gastropods with revolving ornamentation, expanded aperture and plate-like extension of inner lip into aperture somewhat as in *Carinaropsis;* anterior slit short, producing selenizone; ornamentation predominately revolving, usually with numerous fine lirae and low undulations in some species.

Comparisons: *Phragmosphaera* is differentiated from all other bellerophontid genera with revolving ornamentation by its possession of a plate-like diaphragm within the aperture, and from such other bellerophontid genera as possess such a diaphragm by its revolving ornamentation and relatively larger spire.

Range: Silurian—Devonian.

PHRAGMOSPHAERA MIRANDA
Knight, n. sp.
Plate 49, figures 2a–e

Description: Bellerophontid gastropods with aperture rather strongly expanded at sides, deeply bowl-like within and with plate-like extension from posterior lip forming diaphragm reaching approximately halfway across deeper part of aperture; diaphragm seemingly thin, anterior margin gently convex forward in central region, gently concave between central area and lateral edges which extend outward somewhat at sides; margin of anterior lip roundly convex forward with narrow but shallow median sinus culminating in apparently short slit producing seemingly convex selenizone; ornamented by numerous fine revolving lirae and faint transverse undulations; shell seemingly thin, structure unknown.

Dimensions, estimated with allowance for imperfections:

	Length	Width	Height above plane of aperture
Holotype	29.5 mm.	32.8 mm.	12.0 mm.
U.S.N.M. 90702	31.0 mm.	35.0 mm.	11.0 mm.

Remarks: The holotype and one of the paratypes (U. S. N. M. 90702) are internal fillings from a limestone lentil. Both specimens show the sutures of the diaphragm as grooves extending forward from beneath the coiled spire on each side about half-way across the aperture. Another paratype (U. S. N. M. 111756) is an internal filling in shale mashed from above. An incipient fracture along the sutures was exploited and the suspected diaphragm exposed as shown in figures 2d–e on plate 49. As this specimen is an internal filling and the shell matter has been completely removed by solution only a thin film of ferruginous material occurs in the considerably flattened opening originally occupied by the calcareous plate. Although one gets a reasonably accurate outline of the plate in the plane of the bedding it is evident that the thickness of the plate is re-

duced by mashing an unknown, but probably not very great amount. The possibility that the plate-like character of this feature is due solely to mashing in the plane of the bedding seems to be amply disproved by the extensive area covered by it and especially by the sutures of the plates in the two unmashed limestone specimens. There is no evidence of a sharp longitudinal ridge on the inner side of the plate as in *Carinaropsis*, or on the floor of the interior of the whorl as in *Carinaropsis*, *Bucanopsis* or *Sphenosphaera*.

Comparisons and Discussion: *P. miranda* seems similar to *P. lyra* Hall, 1861 as described and figured by him in 1879 (p. 113) and I was at first inclined to so identify the specimens at hand. However Hall's specimens seem to be more coarsely lirate. The whereabouts of Hall's types appears to be unrecorded and no authentic specimens of his species are available. These circumstances together with the fact that the present specimens were derived from the highest formation of the middle Devonian Hamilton group whereas Hall's came from the lowest have led me to erect a new species for them. That the present name may ultimately fall into the synonymy of that proposed by Hall is a recognized possibility.

If *P. lyra* is properly referable to *Phragmosphaera*, as I believe it is, it is likely that the diaphragm was overlooked by Hall for the reason that he was dealing with mashed specimens in shale and the sutural grooves of the diaphragm on such specimens have the appearance of re-entrant chinks produced by mashing. Specimens of *Bellerophon trilirata* Hall, 1879 (p. 117) in the National Museum show a similar diaphragm and are therefore referred to *Phragmosphaera*. This species is distinguished from *P. miranda* by its revolving ridge or angulation on each side of the final whorl. Clarke in 1904 (p. 322 et seq.) showed a number of species with expanded apertures, revolving ornamentation at some stage of growth, and inner lips extended forward into a more or less plate-like diaphragm. Of these *Phragmostoma incisum* (Clarke) 1885 and *Carinaropsis ithagenia* Clarke, 1904, are clearly referable to *Phragmosphaera; Phragmostoma natator* Hall, 1862, and *P. chautauquae* Clarke, 1904, are probably so referable but further study of good specimens is needed for certainty. *P. miranda* differs from *Phragmosphaera incisa* in that the revolving ornamentation of the latter consists of striae rather than lirae. The lirae of *Phragmosphaera ithagenia*, like those of *P. lyra*, appear to be coarser than those of *P. miranda*, but *P. ithagenia* is hardly described adequately and only very fragmentary specimens are illustrated. This name, too, may ultimately find a place in the synonymy of *P. lyra* (Hall).

Hypodigm.: Three specimens as listed below:

Occurrence: One specimen, the holotype (U. S. N. M. 90342) from the West Brook member of the Tully formation, Hamilton group, middle Devonian, at Warner's Gully, 1 mile northeast of Georgetown, New York; one specimen (U. S. N. M. 90702) from the same beds on Muller Creek in the northeast corner of the Pitcher quadrangle, New York; a third specimen (U. S. N. M. 111756) from the shales of *fimbriata* zone of the same beds a mile northeast of Laurens, New York.

COLLECTING LOCALITIES

University of Texas, Bureau of Economic Geology localities: 55-T-43 (Princeton Loc. 633). On the Figure 2 Ranch in Culberson County, Texas, in a gully in the pediment cover at the foot of the Sierra Diablo escarpment about 1 mile north of the conspicuous rhyolitic intrusion.

153-T-6 (Princeton Loc. 630). McCulloch County, Texas; 3.5 miles due east of Rochelle, 0.9 mile south of Rochelle—San Saba highway.

205-T-13. San Saba Co., Texas; 4.5 miles southeast of Richland Springs and 3 miles west and 0.5 mile south of Algerita, 1.5 miles north of Leonard's Ranch.

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MANUSCRIPT RECEIVED MARCH 27, 1945.

JOURNAL OF PALEONTOLOGY, VOL. 19, NO. 4, PP. 341–346, PL. 50, 3 TEXT FIGS., JULY 1945

LATE PALEOZOIC AMMONOIDS FROM THE CHINATI MOUNTAINS OF WEST TEXAS

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ABSTRACT—Late Paleozoic ammonoids have been found in the Chinati Mountains, but available information in regard to them is not very satisfactory. However, one of the faunas is probably Pennsylvanian in age, and the others indicate the presence of Wolfcamp, Leonard, Word?, and Capitan equivalents. A new Permian (Leonard) ammonoid locality in the Finlay Mountains of west Texas is recorded in an appendix.

THE CHINATI MOUNTAINS of Presidio County, Texas, are composed largely of igneous rocks, but around the periphery of the uplift Late Paleozoic sedimentary strata are exposed in four comparatively large areas and at least two smaller ones. A considerable variety of ammonoids has been collected from these Paleozoic strata but the available information in regard to them is not very satisfactory. Through the courtesy of C. L. Baker, Carey Croneis, C. O. Dunbar, Myra Keen, R. C. Moore, S. W. Muller, and F. B. Plummer, I have been able to study many of these specimens, and I wish to take advantage of this opportunity to acknowledge my indebtedness to them as well as to Lee Allen and Howard Webster, who retouched the photographs that accompany this report.

As early as 1904 Udden published on the Chinati Mountain Paleozoics, which he called the "Chinati series" and divided into three formations, in ascending order, the Cieneguita, Alta, and Cibolo. He concluded that at least the lower two of these formations are Pennsylvanian in age, but he expressed the opinion that the uppermost might be Permian. Some years later, Baker (1929) referred all three of Udden's formations to the Permian, stating that the "characteristic lowermost Permian genus *Schwagerina* [= *Pseudoschwagerina*], was found from bottom to top of the Cieneguita." However, Skinner (1940) has recently collected from the type section of the Cieneguita what he regards as Strawn and middle or upper Canyon fusulinids (*Fusulina* ss. and *Triticites*); and he found that both *Schwagerina* and *Pseudoschwagerina* are well represented in the type section of the Cibolo but not in that of the Cieneguita or the Alta. He states that the fusulinids and brachiopods indicate that the upper 50 feet of the Cibolo type section, which is north of the town of Shafter, should be correlated with the lower Leonard and that the rest of it is upper Wolfcamp in age. Furthermore, west of Shafter at the southeastern end of the Chinati Mountains, he found younger beds which contain Word and Capitan fusulinids (particularly *Parafusulina* and *Polydiexodina*), and in Pinto Canyon at the northwestern end of the range he collected "numerous Word fusulinids." He concludes that the Chinati Mountain Paleozoic section appears to consist of a fairly representative sequence of Pennsylvanian beds and a nearly complete Glass Mountain Permian section; that is, that all of the Glass Mountain Permian formations are represented at least in part in the Chinati Mountains, and that the total thickness of the Permian strata there is not less than 6,800 feet. In general, Skinner's study of the fusulinids can be said to support Udden's original conclusions as to the age of the type sections of the three formations which constitute his "Chinati series."

The difference of opinion that has arisen in regard to the age of these formations is, as Skinner points out, due to the "remarkable lithologic resemblance of the Leonard to the Alta and the Word to the Cibolo," and also to the difficulty of correlating the sections exposed in the several Paleozoic areas of the Chinati Mountains. That is, part of the fossils on which certain important conclusions were based came from "exposures other than the type locality," which is north

of Shafter in the vicinity of Sierra Alta.

Insofar as I am able to tell from the literature and the specimens available to me, the ammonoids known from the Chinati Paleozoics do not militate against any of the correlations suggested by Skinner from his study of the fusulinids, and they strongly support most of them. Unfortunately the oldest of these ammonoids belong in a genus that has a long range in the Late Paleozoic, and they are therefore of little value for precise correlation. The rest of them, however, leave little doubt as to the age of the containing strata.

The Cieneguita formation has so far yielded only two species of ammonoids, and

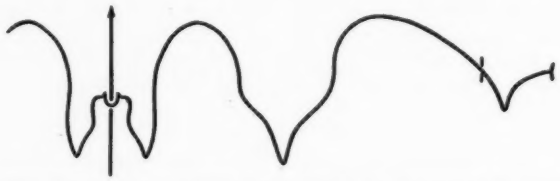


FIG. 1—External suture of *Eoasianites kansasensis* (Miller and Gurley)?, ×5. Based on specimen represented by figures 6, 7 on plate 50, at diameter of about 16½ mm.

both of them belong in the genus *Eoasianites*, of which *Glaphyrites* and *Preshumardites* are synonyms. One of these two species (pl. 50, figs. 1–8) is known from more than a dozen moderately well preserved specimens, the largest of which is estimated to have attained a diameter of some 30 mm.—the adoral quarter-volution of this specimen is nonseptate and presumably therefore represents the living chamber. These specimens are probably referable to *Eoasianites kansasensis* (Miller and Gurley), which was originally described from the Pennsylvanian Kansas City group of western Missouri and has recently been identified by Plummer and Scott from the Graford, Graham, and Gaptank formations of Texas. The Chinati specimens show the same type of growth-lines, sinuous transverse constrictions, and sutures (text fig. 1) as do typical representatives of the species, but their umbilici are somewhat smaller. However, Plummer and Scott found from a study of many well preserved specimens, that in this species the diameter of the umbilicus "varies considerably in different individuals." If, then, the species is to have as much latitude as Plummer and Scott allowed it, it will probably include the Chinati specimens under consideration, and a direct comparison of them with specimens from north-central Texas has convinced me that all may well be conspecific. Nevertheless, it must be kept in mind that in both the United States and Soviet Russia similar congeneric forms are known from widely separated horizons in the Pennsylvanian or Upper Carboniferous and the Lower Permian (Wolfcamp and Sakmarian), and therefore too much significance should not be attached to this apparent occurrence of an upper Pennsylvanian species in the Chinati Mountains. Furthermore, *Eoasianites welleri* (Smith) of the Cherkoee of Missouri and possibly the Strawn (Millsap Lake) of north-central Texas is also very similar to the Chinati specimens, but, like *E. kansasensis*, it has a somewhat wider (though again variable) umbilicus. The poorly preserved specimen from the Wolfcamp formation of the Glass Mountains of west Texas which Plummer and Scott described as *Metalegoceras aricki* is superficially similar to the Chinati specimens being studied, but so little precise information is available in regard to that form that I am uncertain as to even its generic affinities.

The other species of ammonoids that has been found in the Cieneguita is known from only a single large very incomplete septate internal mold which represents part of a phragmacone that was considerably more than 100 mm. in diameter. This specimen has a moderate-sized umbilicus, the width of its whorls is equal to about two-thirds its diameter, and its sutures are of the *Eoasia-*

nites type. Its large size suggests that it might be related to *E. excelsum* (Meek) of the Pennsylvanian of Kansas and possibly Arkansas and Oklahoma, but the general physiognomy of its conch and its sutures are not similar to those of that species. Unfortunately the Chinati specimen is so incomplete that it can not be compared satisfactorily with known forms.

All of these Cieneguita ammonoids were collected by C. L. Baker near the road that leads from the main Shafter-Marfa highway to the Cieneguita Ranch. Professor Baker has written me that they "occur sparingly and very locally in small pockety lens-like deposits." Most of those obtained came from around the base of a small hill some 200 to 300 yards or less south of the ranch road, but a few came from north of that road.

As now interpreted, the Alta formation, which overlies the Cieneguita, has yielded neither ammonoids nor fusulinids. As a matter of fact, the only fossils known from the type section of the Alta are a few brachiopod spines and crinoid columnals, and the formation may be either Pennsylvanian or Permian in age.

The Cibolo formation is very fossiliferous, and locally it carries ammonoids. Almost certainly the oldest Cibolo ammonoids known are two specimens from north of Shafter. One of these (which I have not seen) was identified by J. P. Smith for Udden (1904, p. 21) as "near [*Properrinites*] *cumminsi* White." The other, which may well represent the same species, is the holotype of *Properrinites mooreae* Miller and Furnish (pl. 50, figs. 10, 11), which was found by Mrs. R. C. Moore in a buff sandy limestone on Cibolo Creek below the Cibolo Ranch house some 3 miles north of Shafter. The genus *Properrinites* is quite characteristic of the Lower Permian, and it is known from the Wolfcamp, Hueco, Admiral, and Clyde formations of Texas, and beds of the same general age in Kansas and probably Crimea. The occurrence of a typical representative of this genus in the Cibolo strongly supports Skinner's contention that part of that formation is Wolfcamp in age.

Perrinites, which evolved from *Properrinites* (cf. text figs. 2A and 2B) and became a remarkably stable but very specialized unit, is characteristic of the Leonard zone in west and north-central Texas, New Mexico, Oklahoma, northern and southern Mexico, northern Colombia, Timor, and probably the Pamir Highlands of central Asia. Only one species, *P. hilli* (Smith), is known to occur in North America, and representatives of it have been illustrated from

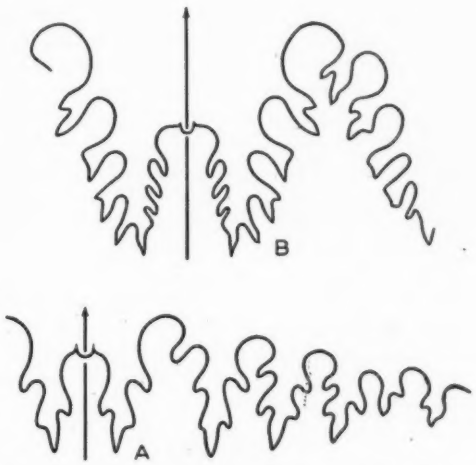


FIG. 2.—Sutures of **(A)** *Properrinites mooreae* Miller and Furnish and **(B)** *Perrinites hilli* (Smith), ×4 and ×3, respectively. **A** is based on specimen illustrated by figures 10, 11 on plate 50, at diameter of about 21 mm. **B**, which represents only ventral portion of suture, is based on specimen illustrated by figures 12–14 on same plate, at diameter of some 35. mm.

at least two localities in the Chinati Mountains: (1) in the type section of the Cibolo formation about 3 miles north of Shafter (pl. 50, figs. 12, 13), and (2) in thin limestones intercalated in a 2,400 foot shale sequence about 1½ miles northwest of Ojo Bonito, several miles northwest of the type section of the Cibolo—according to R. E. King (1930, p. 17) this species is abundant at the latter locality.

On the north flank of Ojo Bonito, in the upper Cibolo Basin ½ mile east of Cibolo Creek and 1 mile south of the 30th parallel, Baker (1929, p. 79) collected ammonoids which he reports were identified for him by J. P. Smith in 1928 as *Agathiceras girtyi*,

Adrianites marathonensis, *Stacheoceras gilliamense*, and *Perrinites?* sp. Smith is stated to have concluded that the strata from which this assemblage came are "correlative with the Word formation." The specimens were deposited at Stanford University, and through the courtesy of Siemon Wm. Muller and Myra Keen they were loaned to me for study. All are preserved in a dark gray finely crystalline limestone. The labels that accompany them indicate that they were identified by M. Gordon, and presumably the identifications were merely checked by Smith. The specimens that were referred to *Agathiceras girtyi* Böse are four in number, and the largest of them is only about 15 mm. in diameter. Their general physiognomy and traces of the surface ornamentation and the sutures preserved on them indicate clearly that they belong in *Agathiceras*, and probably in *A. girtyi;* but that species can not be said to be distinctive of the Word zone, from which it was originally described, for questionable representatives of it have been found in the Hueco, Bone Spring, and Leonard formations of west Texas. The syntypes of *Adrianites marathonensis* Böse, two small only moderately well preserved specimens, are probably immature representatives of *Waagenoceras dieneri* Böse. The single Chinati specimen that was referred to *A. marathonensis* is only about 11.5 mm. in diameter and its preservation leaves much to be desired. The general shape (but not the details) of its sutures can be ascertained, and they together with the form of the conch and the nature of the surface ornamentation seem to indicate an identity with *Adrianites defordi* Miller and Furnish of the Leonard formation of the Glass Mountains. The seven small Chinati specimens that were identified as *Stacheoceras gillimanense* Böse (the syntypes of which belong in *Waagenoceras*) retain traces of the growth-lines and the sutures, both of which indicate that Gordon and Smith were almost certainly correct in referring them to *Stacheoceras*. However, stratigraphically that genus ranges throughout essentially all of the Permian, and since these specimens are almost certainly immature—the largest of them is only about 13 mm. in diameter—their specific affinities can not be determined with any reasonable degree of certainty. One of the specimens from the Chinati Mountains that was placed with question in the genus *Perrinites* is about 25 mm. in diameter and the other is about 30 mm. Neither is well preserved, but both retain portions of the sutures which, together with the general shape of the conch, indicate clearly an identity with *Perrinites hilli* (Smith), a genus and species distinctive of the Leonard zone and not known from strata as young as the Word. Thus all of these forms from the north flank of Ojo Bonito that can be identified specifically indicate a correlation with the Leonard, rather than the Word, and none of them militates against such a correlation.

From a slightly different zone in this same general locality, Baker (1929, pp. 77–78) listed *Medlicottia* and *Waagenoceras*, but I have not been able to locate the specimens to which he referred. *Medlicottia* ranges through most of the Permian system, but *Waagenoceras* has long been regarded as an excellent index to the Word series—however, it is now known to extend up into the Capitan. Stratigraphically, Baker places the beds that yielded these two forms below those from which he collected *Perrinites*, and this fact makes it doubtful that *Waagenoceras* actually occurs at this locality.

About 3 miles north of Shafter, Udden

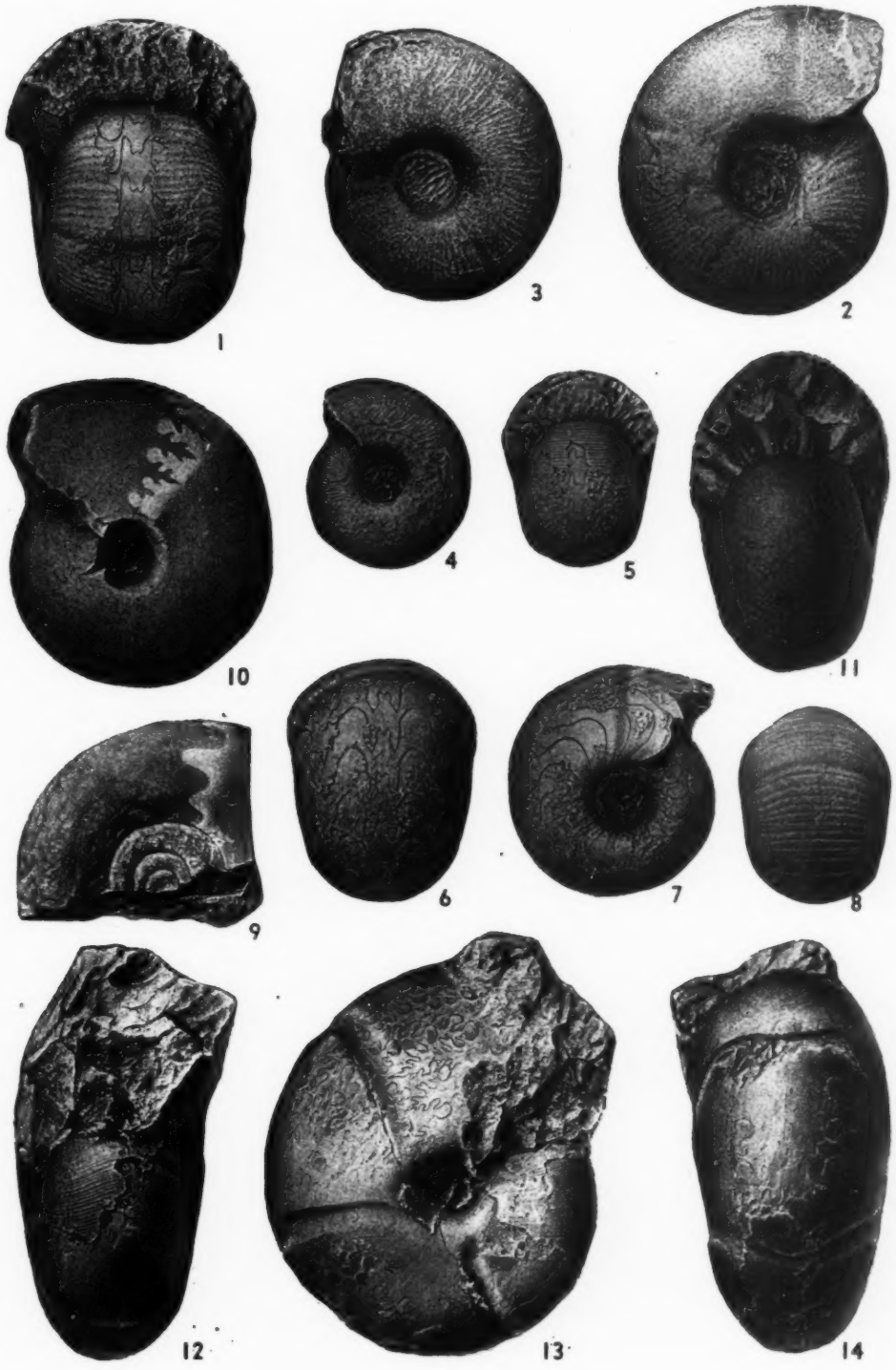
EXPLANATION OF PLATE 50

FIGS. *1–8*—*Eoasianites kansasensis* (Miller and Gurley)? Five specimens (Texas A. and M. Coll.) from Cieneguita formation near road from Shafter-Maria highway to Cieneguita Ranch, Presidio County, Texas, all ×2.

9—*Cibolites uddeni* Plummer and Scott. A worn specimen (Univ. Texas, B378) from Upper Permian (Capitan zone) near Cibolo Ranch house about 3 miles north of Shafter, Presidio County, Texas, ×2.

10, 11—*Properrinites mooreae* Miller and Furnish. The holotype (Univ. Kansas, 6037), from Cibolo formation (Wolfcamp zone) about 3 miles north of Shafter, Texas, ×2.

12, 13—*Perrinites hilli* (Smith). Three views of specimen (Univ. Chicago, 13199) from Cibolo formation (Leonard zone) about 3 miles north of Shafter, Texas, ×1½.



Miller—Late Paleozoic Ammonoids

found a single ammonoid that is Capitan in age. It is an incomplete worn specimen (pl. 50, fig. 9) which was regarded by J. P. Smith and Böse as referable to *Hungarites* or *Dalmatites* of the Triassic, but was placed by Plummer and Scott in their new genus, *Cibolites*, and by Miller and Furnish in still another genus, *Xenodiscites*. The preservation of this specimen leaves much to be desired. However, after studying it carefully, this Chinati Mountain specimen is Capitan in age.

SUMMARY

From the evidence now available, it seems reasonably certain that the two species of *Eoasianites* known from the Cieneguita formation are Pennsylvanian in age. The presence of typical representatives of both *Properrinites* and *Perrinites* in the type section of the Cibolo indicates clearly that part

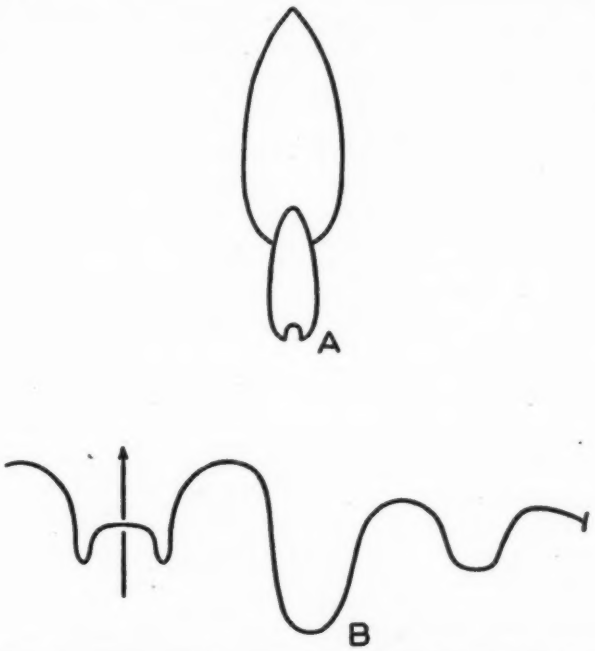


FIG. 3—Diagrammatic cross section (×5) and suture drawing (×7½) of *Cibolites uddeni* Plummer and Scott, based on specimen represented by figure 9 on plate 1. This specimen is incomplete and worn; therefore, these drawings are somewhat generalized and are none too accurate in detail.

both Furnish and I are convinced that Plummer and Scott were correct, and that this specimen belongs in *Cibolites uddeni* P. & S., which is known to occur elsewhere in only the upper Delaware Mountain formation (Capitan zone) in the Guadalupe-Delaware Mountain area of west Texas. The only other representative of the genus *Cibolites* known is *C. mojsisovicsi* Miller of the same general zone in the Las Delicias beds of southwestern Coahuila. Thus, all of the available evidence seems to indicate that of that formation belongs in the Wolfcamp series and part in the Leonard. *Perrinites* is also known to occur (1) on the north flank of Ojo Bonito and (2) northwest of that prominence, several miles northwest of the Cibolo type section; and at these two localities again it is of course Leonard in age. C. L. Baker states that the beds in the vicinity of Ojo Bonito have also yielded representatives of *Medlicottia* and *Waagenoceras* the latter of which (if correctly identified) indicates the occurrence of beds of Word age

in the Chinati Mountains. Finally, a single Capitan ammonoid, *Cibolites uddeni*, has been found about 3 miles north of Shafter. The occurrence of typical representatives of *Properrinites, Perrinites*, and *Cibolites* some 3 miles north of Shafter, indicates that beds of Wolfcamp, Leonard, and Capitan age outcrop at this general locality.

APPENDIX

A New Permian Ammonoid Locality in the Finlay Mountains of West Texas

Near the center of the Finlay Mountains, about 125 miles northwest of Shafter, there is a small exposure of fossiliferous Permian strata. These beds consist of several hundred feet of shale and dark limestone, and lithologically they resemble the Leonard formation in the western part of the Glass Mountains. Their relation to the Leonard, the Bone Spring, and the Hueco formations is concealed by rocks of Lower Cretaceous age which surround the exposure.

In the dark limestone R. E. King (1931, p. 17) found a few ammonoids which he recognized are of Leonard age. These specimens were studied by Miller and Furnish (1940), who identified them as *Propincaoceras knighti* M. & F., *Medlicottia costellifera* M. & F., and *Perrinites hilli tardus* M. & F., a typical Leonard assemblage. All of them came from King's locality 513, that is, from " 'Fossil Hill,' Finlay Dome."

At a nearby locality in the same uplift, "near the top of the Permian exposure along the road to the Mosely Ranch house on the west side of Finlay Dome," W. S. Adkins recently obtained a variety of fusulinids, crinoid columnals, bryozoans, brachiopods, pelecypods, gastropods, and cephalopods. These were deposited in the collections of the Texas Bureau of Economic Geology at Austin, and they were loaned to me for study by F. B. Plummer. Altogether, there are only five ammonoids in the collection. One of these is referable to *Medlicottia costellifera*, and the other four belong in *Perrinites hilli* (Smith). The former of these two species may not be very significant, for it is difficult to distinguish it from *Medlicottia burckhardti* Böse of the Word zone. However, the other species, *Perrinites hilli*, is an excellent index to the Leonard series. Therefore, it can be stated with confidence that the ammonoids found at this new locality confirm the generally accepted opinion that the Permian strata exposed in the Finlay Mountain uplift are Leonard in age.

Manuscript received December 6, 1943.

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JOURNAL OF PALEONTOLOGY, VOL. 19, NO. 4, PP. 347–349, PL. 51, 1 TEXT FIG., JULY 1945

PERMIAN CEPHALOPODS FROM NORTHERN COLOMBIA

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ABSTRACT—Gray dolomitic limestone in a fault block on the western side of the Sierra de Perijá has yielded one nautiloid and two ammonoids: *Titanoceras?* sp., *Medlicottia* sp., and *Perrinites hilli?*. The first two are not particularly significant, but the third indicates clearly that the fauna is of Permian (Leonard) age.

IN A REPORT on the pre-Cretaceous rocks of Colombia, Trumpy (1943) mentioned the discovery of Permian ammonoids in the Sierra de Perijá, just west of the northern part of the Colombian-Venezuelan border. His statements merit amplification because South America has so far produced only one other Paleozoic ammonoid fauna, a Lower Pennsylvanian (Atoka) assemblage described by Thomas from the Amotape Mountains of northwestern Peru.

Trumpy indicated that the Colombian Permian ammonoids were collected by O. Renz of the Compañía de Petróleo Shell de Colombia in a fault block between Upper Cretaceous and Devonian strata east of Manaure on the western side of the Perijá range, which forms the boundary between northern Colombia and Venezuela. The formation is stated to consist of gray slightly dolomitic limestone with layers and nodules of black chert. Fossils are abundant in it, and a list of the fauna, prepared except for the cephalopods, by Williams and published by Trumpy, indicates that it contains sponges?, crinoid columnals, and several types of brachiopods, pelecypods, and gastropods, as well as cephalopods. Both the brachiopods and the cephalopods suggest a Permian (Leonard) age for the assemblage. Furthermore, Trumpy added that "farther south in the Perijá range, on the Río Mula, volcanic red beds contain conglomerates with limestone boulders, in which Permian Fusulinae occur, and from which Emeis determined *Paraschwagerina yabei* (Staff). The limestone has not been found in place and may have been removed by post-Permian erosion. Elsewhere in Colombia, the Permian has not yet been proven by fossils, but quite possibly the top of the Gachalá and Labateca sections [in and near the central portion of Colombia] extend into this period."

Only three specimens of Permian cephalopods are known from Colombia, and all of them came from the same locality east of Manaure. They are preserved in a dark gray fine-grained homogeneous limestone which contains a few veins of white crystalline calcite.

One of the three is a fragment of a septate whorl of a large coiled nautiloid. The volution represented was at least 60 mm. wide. The septa are moderately convex apicad, and the lateral walls of the conch are essentially flat. The general appearance of the specimen suggests relationship to *Titanoceras* of the type of *T. sanandreasense* M., D., & C., but so small a portion of the conch is represented that even a generic determination can not be made satisfactorily.

Both of the other cephalopods under consideration are ammonoids. One is a poorly preserved internal mold of parts of two volutions of a phragmacone which clearly belongs in the genus *Medlicottia*. The outer of the two volutions of this specimen was some 70 mm. high and about 18 mm. wide. It is flattened laterally, with the lateral zones essentially parallel but with the ventrolateral zones converging ventrad. The ventral zone, which is about 6 mm. wide, bears a rather deep rounded median groove that is bordered on either side by a prominent ventrolateral keel (text fig. 1*B*). The portions of the sutures preserved show that the ventral lobe is deep and narrow and that it bears prominent lateral denticulations (pl. 51, fig. 4). The lateral lobes, which are fairly numerous, are long, slender, and prominently

bifid, and rather deep notches are developed in their lateral zones, which in general are essentially parallel. The lateral saddles are rounded. All of the characters of this specimen that can be determined coincide well with those of *M. whitneyi* Böse of the Leonard series of Texas and Coahuila, but it should be clearly understood that this general type of medlicottid is known to range from early Leonard time to the end of the Permian period, and only well-preserved specimens can be identified specifically.

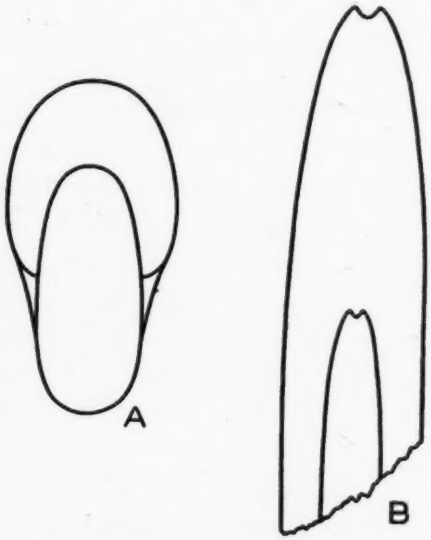


FIG. 1.—Outline ventral view of *Perrinites hilli* (Smith)? and diagrammatic cross section of *Medlicottia* sp., both ×1. **A** represents the penultimate volution of the specimen illustrated by figures 1–3 on plate 51; **B** represents the specimen illustrated by figures 4, 5 on the same plate.

By far the most significant of the three specimens available is a representative of the genus *Perrinites*. Small portions of the outer volution of this specimen show that the phragmacone attained a diameter of more than 100 mm., and that at least certain portions of the external sutures (pl. 51, fig. 1) are precisely similar to those of the genotype, *P. hilli* (Smith) of the Leonard and equivalent beds in Texas, Oklahoma, New Mexico, Coahuila, and Chiapas. The shape of all but the ventral portions of the internal sutures is shown at the adoral end of the essentially complete whorl (pl. 51, fig. 2), and here also a striking similarity to *P. hilli* is immediately apparent. The umbilicus is rather small but not closed. The conch is subdiscoidal (text fig. 1*A*), as the whorls are flattened laterally, rounded ventrally, and impressed dorsally. Where the diameter of the specimen is about 45 mm., the whorls are about 23 mm. high and 25 mm. wide, and the diameter of the umbilicus is about 6 mm. All of these measurements as well as the general physiognomy of the specimen coincide almost precisely with those of typical *P. hilli* and there is no reason to doubt that the relationship is very close—in all probability this Colombian specimen is conspecific with the Texas type specimen.

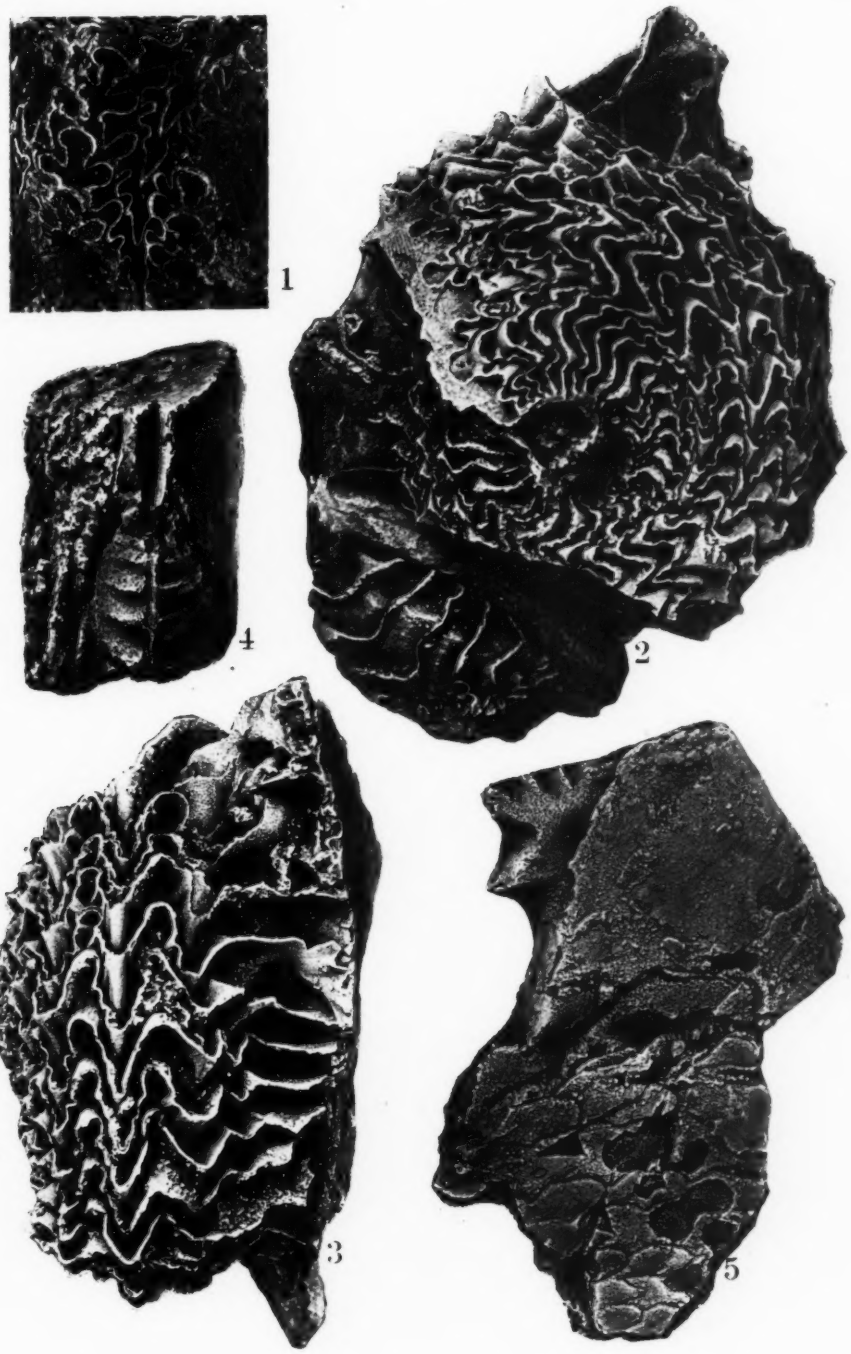
The first two cephalopods just discussed are not very significant from a stratigraphic point of view, but the third (*Perrinites hilli*?) indicates clearly that the fauna is Permian in age and that the containing beds are to be correlated with part of the Leonard formation of west Texas and equivalent beds in adjacent areas. That is, the genus *Perrinites* has been found to be of widespread occurrence in southwestern United States, northern and southern Mexico, Timor, and probably the Pamir Highlands of central Asia, and in all of these widely separated areas the beds which contain it are of approximately the same age. It is a remarkably stable but very highly specialized unit which appears to have a rather small stratigraphic range in the Permian, and it is generally rec-

EXPLANATION OF PLATE 51

Both specimens illustrated are from the Permian (Leonard equivalent) in the Sierra de Perijá east of Manaure, Colombia; and both are in the collections of the Compañía de Petróleo Shell de Colombia.

FIGS. *1–3*—*Perrinites hilli* (Smith)? An enlargement of part of the left lateral zone of the internal mold, showing the third lateral lobe of the external sutures at a diameter of some 100 mm., ×2; and lateral and ventral views of the same specimen as the preceding, both ×1½.

4, 5—*Medlicottia* sp. Ventral and lateral views of a poorly preserved fragment, ×1½.



Miller and Williams—Permian Cephalopods

ognized as an excellent index to the Leonard zone.

In concluding we wish to acknowledge our indebtedness to Howard Webster who retouched the photographs which accompany this report, and to D. Trumpy for granting us permission to publish this study of material assembled by and belonging to the Compañía de Petróleo Shell de Colombia.

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JOURNAL OF PALEONTOLOGY, VOL. 19, NO. 4, PP. 350–354, PLS. 52, 53, JULY 1945

CALCAREOUS ALGAE AS USEFUL MICROFOSSILS

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ABSTRACT—Two groups of calcareous algae, the Dasycladaceae and the Corallinaceae, offer possibilities as microfossils useful in correlation. Their general characters and diagnostic structures are described and illustrated. Charts show the system of classification, of each group, and the time distribution of the more important genera of the Dasycladaceae. Plates illustrate the structures and more common Tertiary genera. A short bibliography gives the basic references.

INTRODUCTION

MANY of the fossil lime-depositing algae have retained little trace of their original structure, and others appear to have persisted through long periods of time without significant structural change. Such types are valueless to the geologist except as indicators of environment. There are two groups, however, which show recognizable structural features and changed and developed more or less consistency and rapidity throughout geological time. They can be classified as genera and species of relatively restricted time range and have possible usefulness in correlation. These groups are the Dasycladaceae and the coralline algae. Table 1 shows their systematic position and lists some of the more important Tertiary genera. Both developed long before the Tertiary but more work has been done on Tertiary than earlier forms. The following discussion is based mainly on the Tertiary forms but table 2 lists the important genera of older periods.

The Dasycladaceaea or Siphonous Algae—This group sometimes called the Siphoneae Verticilatae is known largely through the work of J. Pia of Vienna. Structurally the organisms consist of a central stalk or stem from which grow very short primary branches supporting tufts of fine closely spaced hair-like growths. The entire plant suggests a small cylindrical brush. Calcium carbonate is usually deposited around the

TABLE 1. CLASSIFICATION OF THE DASYCLADACEAE AND THE CORALLINACEAE

Class	Family	Subfamily	Genera
Chlorophyceae	Dasycladaceae		*Neomeris* *Larvaria* *Cymopolia* *Meminella* *Lemoinella* *Dactylopora* *Zittelina* *Maupasia* *Terquemella* *Uteria* *Acicularia* *Clypeina*
Rhodophyceae	Corallinaceae	Melobesieae	*Melobesia* *Lithothamnium* *Mesophyllum* *Lithophyllum* *Archaeolithothamnium*
		Corallineae	*Corallina* *Jania* *Amphiroa*

TABLE 2. SOME OF THE MORE IMPORTANT FOSSIL GENERA OF THE DASYCLADACEAE

Period												Genus
Cambrian	Ordovician	Silurian	Devonian	Mississippian	Pennsylvanain	Permian	Triassic	Jurassic	Cretaceous	Tertiary	Recent	
								x		x	x	*Acicularia*
				?	x	?						*Actinoporella*
										x		*Anthracoporella*
										x		*Belzungia*
										x		*Carpenterella*
										x		*Clypeina*
		x										*Conipora*
										x		*Coclosphaeridium*
										x		*Cympolia*
										x		*Dactylopora*
							x					*Digitella*
						x		x				*Diplopora*
												Epimastopora
						?	x	x				*Ganiolina*
							x			x		*Griphoporella*
				x								*Gyroporella*
										x		*Jodotella*
										x		*Koninckopora*
										x		*Larvaria*
								x				*Lemoinella*
						x	x					*Linoporella*
		x								x		*Macroporella*
						x			x	x		*Mastopora*
							x					*Maupasia*
									x	x		*Munieria*
							x					*Neomeris*
								x				*Oligoporella*
										x		*Palaeocladus*
							x					*Parkerella*
								x	x			*Petrascula*
							x			x		*Physoporella*
								x				*Salpingoporella*
										x		*Sestrosphaera*
							x					*Terquemella*
										x		*Teuilloporella*
								x				*Thyrsoporella*
						x				x		*Triploporella*
												Uteria
										x		*Vermiporella*
												Zittelina

stem and may extend to the base of the tufts. After the death of the plant the vegetable tissues decay so the fossil usually consists of a hollow calcareous body, cylindrical or club-shaped, open at one end and perforated by numerous openings. In the older more consolidated deposits the cylinder and openings are often filled with calcite of a different texture and tint than the original "wall" deposit. A few species attained a length of a centimeter or more but most are only a fraction of this size. On a weathered limestone surface they may superficially resemble fusulinids or other large Foraminifera and some of the first fossil forms described were classed as Foraminifera (Parker and Jones, 1860; Munier-Chalmas, 1877–1879; Jones 1882). They are frequently

associated with Foraminifera but average somewhat larger in size.

Most modern forms live in shallow water and the available evidence points to a similar environment for the fossil forms.

Classification is based largely on (a) the general shape, (b) the character, arrangement, and number of the primary branches; (c) number and position of sporangia (spore cases) if present, (d) secondary branches.

Dasycladaceae are known from the Ordovician to the present. The ranges of the better known genera are listed in table 2.

Pia (1920, 1926, 1936) has shown that fossil forms usually have only a short geologic range and so have possible value for correlation. In Europe they have been so used especially in work with Triassic, Cretaceous, Eocene, and Miocene strata.

The Corallinaceae or Coralline Algae.—These occur as crusts, nodular masses, or coral-like growths with pronged or branching protuberances. They are most distinctive structurally because the tissues are reinforced with lime deposited within the cell walls. Thus the fossils show good cellular structure and arrangement in thin sections. The tissues are composed of rectangular cells which do not exceed a length of 40μ in the Melobesieae but may be as much as 100μ long in the Corallineae. Thin sections magnified 100 to 200 times show this structure plainly.

The organism or thallus is composed of the following elements: the hypothallium usually consisting of many rows of cells (sometimes reduced to a single row) by which the crust is attached to the substratum. Above this comes the second layer of tissue or perithallium, consisting of many rows of cells, in which are imbedded the reproductive organs (sporangia). The sporangia may be isolated or grouped together in conceptacles. Conceptacles are rarely seen in the Corallineae, but are almost always present in the Melobesieae and are of the highest value in systematic classification. Apertures (for the escape of spores) are found in the roofs of conceptacles. There may be a single aperture as in *Lithophyllum* or a great number (20 to 100) as in *Lithothamnium*.

Generic and specific distinctions are based on differences in development of the hypothallium, the perithallium, the conceptacles and their apertures.

Many of the Corallinaceae possess true branches each of which consists of a central erect mass of tissue, the medullary hypothallium formed by the prolongation of the basilar hypothallium, surrounded by the perithallium. Nodules (mammelons, protuberances) are structurally different. They are simply bulges formed by the addition of more rows of perithallial cells to the primary thallus or by the superposition of many individual thalli. They do not possess any medullary tissue.

Many of the Corallinaceae show the presence of zonation as a result of periodic growth. This character is of some systematic importance.

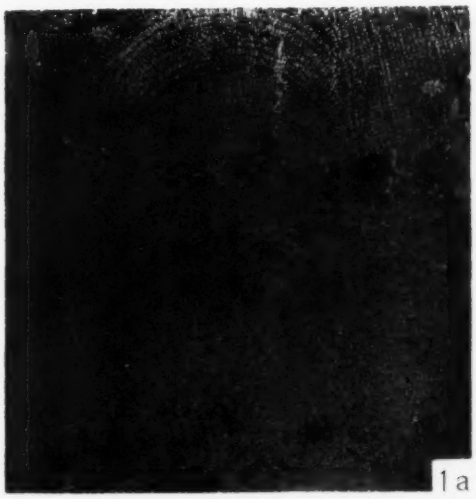
The subfamily Melobesieae is considerably better known and apparently more important paleontologically than the Corallineae. The diagnostic features of the more important genera of the Melobesieae are given below.

Genus ARCHAEOLITHOTHAMNIUM Rothpletz
Plate 52, figure 2

This genus, first described in 1891 and redefined by Madame Lemoine (1917) is characterized by the following features: Sporangia isolated, ovoid, arranged in concentric zones. Arrangement of hypothallial cells in loose files without continuous horizontal partitions, earlier files creeping or horizontal, later ones oblique, erect, gradually merging into perithallium. Perithallium of crust and medullary hypothallium of branches have cells arranged in radiating pattern.

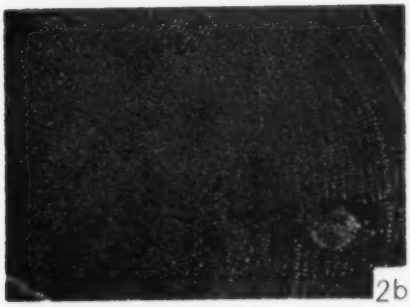
EXPLANATION OF PLATE 52

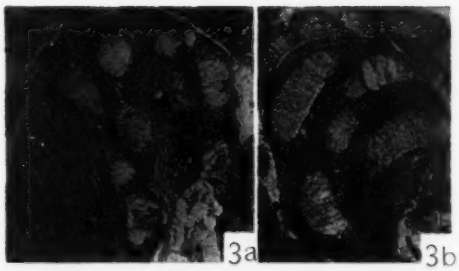
FIGS. *1*—*Lithophyllum sierrae-blancae* Howe. Eocene of California. ×60.
2—*Archaeolithothamnium keenani* Howe. Eocene of California. ×60.
3—*Mesophyllum schenckii* Howe. Eocene of California. ×60.
4—*Lithothamnium isthmi* Howe. Oligocene of the Canal Zone. ×75.
After Howe 1918 and 1934


1a

1b

2a


2b

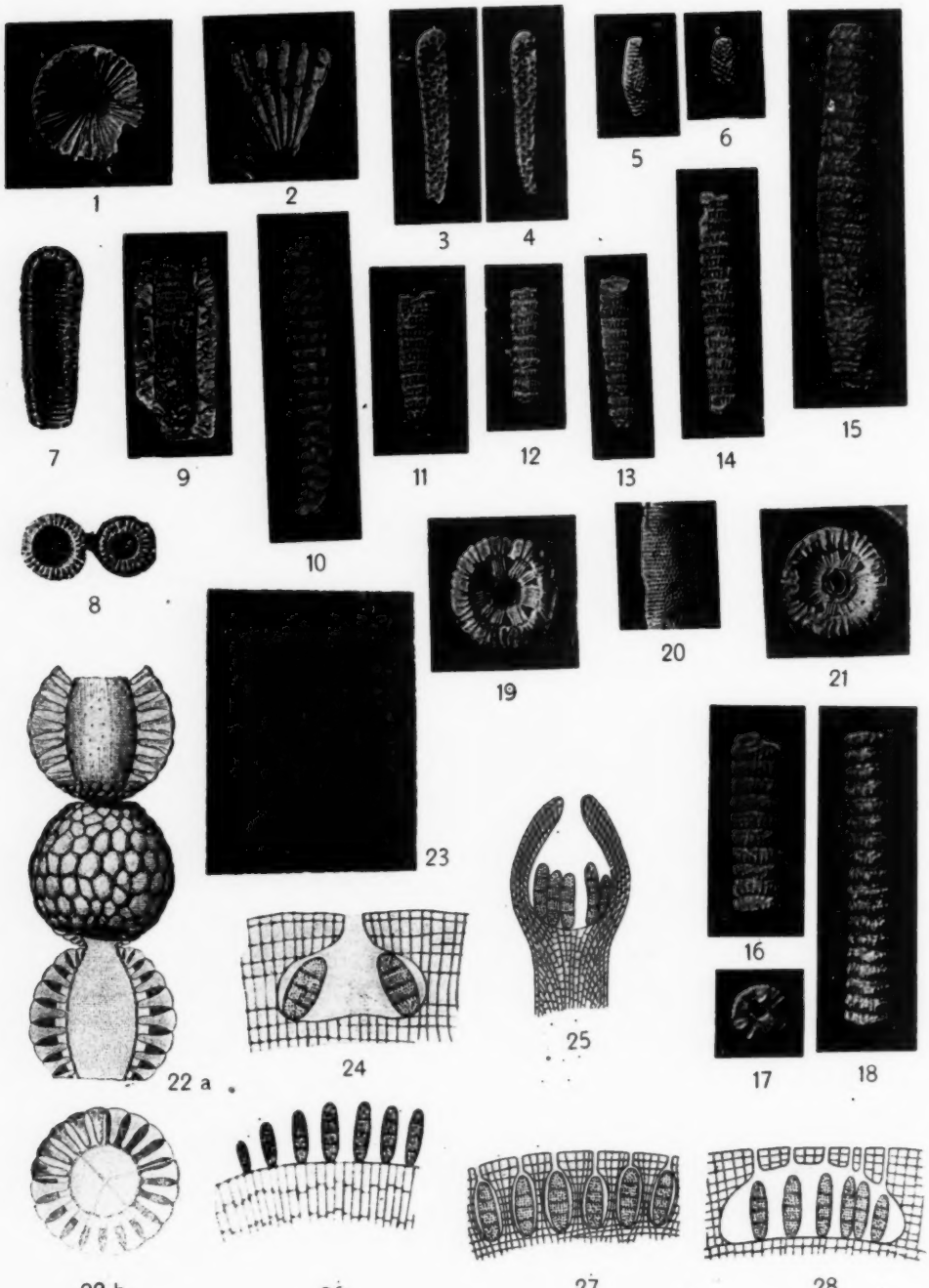

3a

3b

3c

4

Johnson—Calcareous Algae



Johnson—Calcareous Algae

Genus LITHOPHYLLUM Philippi
Plate 52, figure 1

Madame Lemoine characterized this genus as follows: Concentric arrangement of cells partial or complete. Basilar hypothallium of crust shows concentric arrangement, or rarely consists of single row of horizontal cells. Medullary tissue of branches formed by concentric rows of cells; perithallium of crust and branch formed of cells arranged in files or concentric rows. Conceptacles (with sporangia) provided with single apertures. Zonation absent.

Genus MESOPHYLLUM Lemoine
Plate 52, figure 3

This genus is very similar to *Lithophyllum* but is distinguished from the latter by the presence of zonation in the tissues and by the numerous apertures in the conceptacles (with sporangia). Conceptacles with cystocarps instead of sporangia have, however, a single aperture as in *Lithophyllum*.

Zonation is the result of periodic growth, and the zones appear as dark, wavy or concentric lines or streaks under low magnification. The growth-lines are sometimes preceded by a row of small cells. Zonation is also characteristic of the genus *Lithothamnium*.

Genus LITHOTHAMNIUM (Philippi) Foslie
Plate 52, figure 4

This occurs as a crust-like growth or as small nodular masses with or without wart-like protuberances. In thin section the hypothallium consists either of irregular rows of cells or of rows concentrically arranged. Above, the perithallial cells occur in horizontal rows. The partitions between the cells do not continue from row to row. Zonal arrangement of tissues above the hypothallium is usually pronounced. Conceptacles are either buried in the thallus or project above it. Apertures in the roof of the conceptacles are numerous (20 to 100).

Environment.—Representatives of the Dasycladaceae and the Corallinaceae are seldom found together. The former develop best in shallow waters, on mud flats in lagoons and in similar environments, while the latter grow attached to rocky bottoms, on reefs, especially the top and outer side where there is considerable agitation of the water. While they commonly grow in shallow water they may extend down to moderate depths, though not beyond the zone of light penetration.

Use.—The Dasycladaceae have been utilized for correlation of Permian rocks in Yugoslavia and Greece, of Triassic rocks in Austria, Hungary, and Yugoslavia, of the older Tertiary strata in France and England.

The Corallinacea from the Tertiary of the Mediterranean region, France and Spain have been investigated more than any other.

Like other largely unstudied groups of fossils a great amount of preliminary work must be done before they can be widely utilized. The fossils must be described and the geologic and geographic ranges of genera and species must be determined.

No species of either group has been described from the Tertiary of the American Gulf Coast, but some of the depositional facies in that region should contain abundant specimens. Fossil forms of these two groups have probably been present in many well samples but have not been recognized.

EXPLANATION OF PLATE 53

FIGS. *1–4*—*Acicularia schenckii* (Möbius) Solms-L. Recent. Bermuda. (*1*×5; *2*, *3*×15).
5–6—*Cymopolia* sp. Eocene (*5*×12) France (*6*×15).
7–8—*Dactylopora cylindracea* LK. (×3), Eocene, Paris Basin.
9–12—*Larvaria davisi* Morellet (×12) Eocene, Sussex, England.
13–16—*Larvaria encrinula* Defrance (×12) Eocene, France.
17–19—*Noemeris* (*Decaisnella*) *annulata* Dickie (*17–19*×12; *18*×6) Recent, Bermuda.
20—Pia's reconstruction of *Mizzia*.
21—Mizzia limestone, Permian (×1) Apache Mountains, Texas.
22–26—Diagrams showing arrangement and position of spore cases among the *Corallinaceae*; *22*, *Lithophyllum*; *23*, *Corallina*; *24*, *Solenopora*; *25*, *Archaeolithothamnium*; *26*, *Lithothamnium*.
Figures *1* to *19* from Morellet, British Museum, 1939, *20* and *22* to *26* after Pia, 1927.

Recently M. A. Hanna of Houston sent me a washed sample from the Eocene of Mississippi which contained some beautifully preserved fragments of Corallinaceae including several genera. Howe (1934) described a similar flora from the Eocene of California. Undoubtedly many more occurrences are awaiting discovery and recognition. Over a year ago Virgil Barnes of Austin sent in a collection of Dasycladaceae from the Cretaceous of Gillespie County, Texas. These are described in a paper which should be published shortly.

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PAPER GIVEN AT DALLAS MEETING OF S.E.P.M. MARCH 23, 1944.
MANUSCRIPT RECEIVED MAY 26, 1944.

JOURNAL OF PALEONTOLOGY, VOL. 19, NO. 4, PP. 355–367, PLS. 54–56, JULY 1945

UPPER DEVONIAN CONODONTS FROM THE INDEPENDENCE SHALE (?) OF IOWA

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ABSTRACT—A considerable variety of well preserved conodonts is illustrated and described from a small outcrop near Middle Amana, Iowa. It is concluded that they are Upper Devonian in age and related to forms known from the Olentangy shale of central Ohio.

THE NAME Independence was proposed by Calvin in 1878 for fossiliferous dark gray shale exposed in an exploratory shaft near Independence, Iowa. This shaft has long been filled, but Calvin indicated that the shale occurs there immediately beneath the Cedar Valley limestone.

The age of both these formations is still somewhat uncertain. Within the past decade, Stainbrook has concluded that the Independence lies unconformably above the Davenport limestone (uppermost Wapsipinicon) and that it is overlain conformably by the Cedar Valley limestone. However, Cooper and Warthin have recently contended that the Independence is not in its normal position, but that it fills sinks and caverns and that it has a fauna which is younger than that of the Cedar Valley. Stainbrook regards the Cedar Valley as Upper Devonian whereas Cooper and Warthin refer it to the Middle Devonian. Its fauna seems to be more or less equivocal, as is that known from the type section of the Independence. However, among the exposures which Stainbrook has referred to the Independence are beds that outcrop near Brandon and Middle Amana, Iowa, and these have yielded goniatites (*Ponticeras* and *Manticoceras*) that are definitely Upper Devonian in age.

The exposure near Middle Amana is along State highway 220 about 0.4 mile west of the village in the center of the N. ½ sec. 29, T. 81 N., R. 9 W., Lenox Township. Several feet of shale can be seen here in a cut on the north side of the road. The upper portion of these beds is somewhat arenaceous, whereas the lower is distinctly calcareous and carries many limonite grains. Samples were collected at intervals of about 10 inches and were examined for microfossils. They yielded a well-preserved and varied conodont fauna which constitutes the basis for the present report. It was found that conodonts are most abundant in the lower part of the exposure but are present throughout.

The assemblage obtained consists largely of new species and contains representatives of two new genera. Nevertheless, in general it appears to resemble faunas known from the Grassy Creek shale of Missouri, the New Albany shale of Indiana, and the Olentangy shale of central Ohio, all of which are Upper Devonian in age.

The fauna under consideration contains one species, *Bryantodus inequalis* Branson and Mehl [not Holmes], that occurs also in the Grassy Creek, and in common with the Olentangy it carries the following six forms: *Ancyrodella buckeyensis*, *Bryantodus argutus*, *Ctenognathus falcatus*, *Falcodus incultus*, *Hindeodella lambtonensis*, and *Palmatolepis flabelliformis*, all of Stauffer. These six mutually-held species, together with the general similarity of the faunas, indicate that the Middle Amana beds are approximately equivalent to the Olentangy. Unfortunately, the age of the Olentangy has also been a subject of controversy. However, Baker has recently shown that at the type locality in Delaware, Ohio, the Olentangy is clearly Upper Devonian, and that, like the beds near Middle Amana, it carries the goniatite genus *Manticoceras*.

It has been believed by some that these beds near Middle Amana are closely related to the Lime Creek formation of northeastern Iowa. However, numerous samples from that formation were loaned by Mr. John B. Carrier, and they yielded only a

few conodonts, none of which seems to support the alleged relationship. Furthermore, scolecodonts and charophyte oogonia are abundant in the Lime Creek, but none was found in any of the samples from near Middle Amana.

Professor C. R. Stauffer kindly allowed me to examine the extensive collections of conodonts that he described from the Cedar Valley formation. None of them is conspecific with the forms under consideration. Also, the absence of such widespread and characteristic Upper Devonian-Lower Mississippian genera as *Palmatolepis* and *Ancyrodella* in the Cedar Valley assemblage is noteworthy, and in general the Cedar Valley conodonts seem to be less advanced than those of the Middle Amana beds.

In summary it can be said that the conodonts, taken by themselves, indicate that the beds exposed near Middle Amana are Upper Devonian in age and are approximately correlative with the Olentangy shale of central Ohio. Furthermore, they do not seem to be closely related to the few Lime Creek forms known, and they are probably younger than those described from the Cedar Valley.

Acknowledgment is due to Mr. John B. Carrier and Professor C. R. Stauffer for permitting direct comparisons with their specimens. Particular thanks are due to Professor A. K. Miller for advice and assistance throughout the preparation of this report. The accompanying drawings were made by Miss Wendy Robb.

ADDENDUM

Since this report was completed and submitted for publication, Stainbrook (Am. Jour. Sci., vol. 243, pp. 157–158, 1945) has expressed the conclusion that the beds which yielded the conodonts described below "are younger than the true Independence and probably older than the Lime Creek."

SYSTEMATIC PALEONTOLOGY

ANCYRODELLA BUCKEYENSIS Stauffer

Plate 54, figure 11

Ancyrodella buckeyensis Stauffer, 1938, Jour. Paleontology, vol. 12, p. 418, pl. 52, figs. 17, 18, 23, 24.

This form is close to *A. nodosa* and *A. hamata*, described by Ulrich and Bassler from the Rhinestreet shale of New York and the Hardin sandstone of Tennessee, respectively. *A. lobata* Branson and Mehl from the Grassy Creek shale of Missouri is also similar.

Remarks.—Apparently *Ancyrodella* does not appear stratigraphically below the Upper Devonian and it ranges into the base of the Mississippian. In his report on the Cedar Valley conodonts, Stauffer does not record any representatives of this genus, which presumably means that it begins somewhere above the Cedar Valley limestone of the Devonian and ranges up into the Lower Mississippian. If *Ancyrodella* proves to have the limited stratigraphic range inferred, the beds of the Middle Amana outcrop are post-Cedar Valley in age.

Occurrence.—Stauffer's type specimens came from the Olentangy shale near Delaware and Dublin, Ohio. The specimen figured in this paper is from the Independence shale (?), Middle Amana, Iowa.

Plesiotype.—State Univ. Iowa, 2903.

ANCYROGNATHUS TRIANGULARIS Youngquist, n. sp.

Plate 54, figure 7

Plate thick, divided into two lobes posteriorly, one of which diverges at a high angle from axis of other lobe and main axis of plate. Both lobes bear prominent nodose ridges which join to form a carina about midway, or slightly posterior, on long axis of plate. Carina extends anteriorly, straight or slightly curved, resolved into small blade at anterior end. Anterior portion of plate strongly arched downward; remainder, including lobes, flat or slightly convex. Oral surface ornamented with low closely spaced nodes. Aboral triangular escutcheon with apices of triangle resolved into ridges extending to both lobes, and into slight keel extending anteriorly directly beneath carina on oral surface.

Remarks.—The type specimens of this species, vary considerable in size. Also the position of the lobe that is almost normal to the axis of the carina is variable. In some specimens it diverges at right angles from the main plate and is situated about midway along the long axis of the plate; in others (as illustrated) it diverges at a moderate angle

from the longitudinal axis and is located posteriorly.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2904 (figured specimen) and 2905 (3 unfigured specimens).

ANGULODUS sp.
Plate 54, figure 13

Bar rather thick, long, compressed laterally, slightly bowed, bearing series of large denticles separated by from one to three smaller denticles. Denticles originate deep in bar, are distinctly rounded in cross section. Posterior end of bar slightly deflected inward laterally. Oral face of bar laterally broadened to form slight shoulder.

Remarks.—Many representatives of this form are present in the collection under consideration, but most of them are fragmentary. A certain amount of variation is evident and all specimens may not be conspecific.

Occurrence.—Abundant in the Independence shale (?), Middle Amana, Iowa.

Repository.—State Univ. Iowa, 2906 (figured specimen) and 2907 (9 unfigured specimens).

BRYANTODUS AMANAENSIS Youngquist, n. sp.
Plate 54, figure 12

Base moderately thick, laterally curved or bowed, somewhat arched, with a distinct inward horizontal bend near posterior end. Denticles and cusp confluent from bases almost to apices, flattened somewhat on their exterior surfaces, rounded on their inner surfaces. Denticles and cusp moderately inclined inward in their upper portions—a feature not readily seen or illustrated in exterior view. Cusp confluent with denticles but set off from them by its greater size. Base with no definite aboral excavation or escutcheon but possesses distinct keel lying on inner margin of base anteriorly, progressively trends toward median position posteriorly.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Holotype.—State Univ. Iowa, 2908.

BRYANTODUS ARGUTUS Stauffer
Plate 54, figure 10

Bryantodus argutus Stauffer, 1938, Jour. Paleontology, vol. 12, p. 419, pl. 48, figs. 16, 20.

Base somewhat sinuous, surmounted by denticles which may be moderately offset laterally from one another in their axes of growth. Denticles confluent at least half way from base to apices. Base bears broad shallow excavation aborally which is replaced by distinct keel at both extremities.

Remarks.—As noted by Kirk (conodonts from Harding sandstone of Colorado), Stauffer (Middle Ordovician specimens from Kansas), and others, conodonts may be attached basally to fragments of plate-like material variously interpreted to be bone-like or chitinous. Similar attachment of some specimens from the Middle Amana locality occurs and the most nearly perfect specimen of *B. argutus* adheres basally to such plate-like material which is shown in the illustration.

Occurrence.—Originally described from middle of Olentangy shale at Deep Run, Franklin County. Ohio, Also occurs in Independence shale (?), Middle Amana, Iowa.

Plesiotype.—State Univ. Iowa, 2909.

BRYANTODUS CHESTERI Youngquist, n. sp.
Plate 55, figures 12, 13

Bar generally arched anterior to cusp with definite keel aborally. Bar bowed laterally anterior to cusp but relatively straight or only slightly bowed and arched posterior to cusp. Median lateral ridge on anterior portion of bar approaches oral side posteriorly. Bar slightly keeled posteriorly. Cusp set deep in bar, moderately to strongly rounded, inclined posteriorly. Many specimens with prominent node on bar projecting aborally in line with insertion of cusp in bar. There are 6 to 8 denticles anterior to cusp, somewhat fused, noticeably confluent except near apices; 8 to 12 posterior to cusp, crowded somewhat but not fused. Posterior denticles deeply inserted in bar; anterior denticles not as deeply set. Many specimens with very minute germ denticles at base of insertion of posterior denticles.

Remarks.—This form resembles *B. cognatus* Huddle from the New Albany shale of Indiana, *B. inequalis* Holmes [not Branson and Mehl] from the Chattanooga shale of Alabama, and *B. nitidus* Ulrich and Bassler from the Rhinestreet shale of New York but differs from them in that the anterior denticles have a tendency to broaden by fusion with adjacent denticles. According to Ulrich and Bassler this type of conodont belongs to a group which is particularly well developed in the Mississippian black shales. The two specimens figured in this paper are right and left individuals.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2910 (2 figured specimens) and 2911 (unfigured specimen).

BRYANTODUS INEQUALIS Branson and Mehl
Plate 55, figure 15

Bryantodus inequalis Branson and Mehl, 1933, Missouri Univ. Studies, vol. 8, p. 219, pl. 16, figs. 17, 18. [Not *B. inequalis* Holmes, 1928, U. S. Nat. Mus., Proc., vol. 72, art. 5, p. 27, pl. 10, figs. 1, 2.]

Figured specimen represents cusp and posterior portion of bar; anterior portion missing. Unfigured specimen fractured in approximately the same manner.

Remarks.—As indicated in the synonymy the specific name proposed by Branson and Mehl was preoccupied by Holmes, and a substitute needs to be proposed.

Occurrence.—Independence shale (?), Middle Amana, Iowa. Originally described from the Grassy Creek shale of Missouri.

Plesiotypes.—State Univ. Iowa, 2912 (figured specimen) and 2913 (unfigured specimen).

CTENOGNATHUS FALCATUS Stauffer
Plate 55, figure 1

Ctenognathus falcatus Stauffer, 1938, Jour. Paleontology, vol. 12, p. 425, pl. 48, figs. 1, 5.

This form is very similar to Stauffer's specimens from the Olentangy. The base is notably thin and fragile, being compressed and bowed laterally. Only a very slight escutcheon is present beneath the cusp. Most of the denticles originate deep within the base and are laterally compressed and fused except near their apices. A few germ denticles or wedges are present deep within the bar.

Occurrence.—Olentangy shale at Delaware and Deep Run, Ohio. Also in Independence shale (?), Middle Amana, Iowa.

Plesiotype.—State Univ. Iowa, 2914.

Genus ELSONELLA Youngquist, n. gen.

Bar symmetrically and acutely arched, laterally compressed; may bear inner and outer lateral flanges on aboral margins; slightly or strongly excavated aborally, tapers to rounded processes at both ends. Cusp present, inserted directly above apex of arch of bar, may be vertical or oblique. Ten to 14 denticles on each side of cusp fused to form very sharp blade-like oral surface. Individual denticles may or may not be distinguishable in transmitted light. Denticles usually light in color grading gradually into amber colored bar rather than being distinctly inserted. Chief characteristics of genus are: symmetrical arching of bar, nearly complete fusion of denticles into an oral blade, presence of distinct cusp inserted directly above apex of arching. This genus resembles *Palmatodella* Ulrich and Bassler but differs in that the denticles are broad and almost totally confluent rather than hair-like.

Genotype.—*Elsonella prima* Youngquist, n. sp.

ELSONELLA PRIMA Youngquist, n. sp.
Plate 56, figure 5

Bar acutely arched, symmetrical, bearing outer and inner flanges near aboral edge, broadest at apex of arch, broadly excavated aborally beneath cusp, laterally compressed. Ends of bar form rounded laterally compressed processes. Insertion of cusp symmetrical with specimen as a whole. Cusp confluent with adjacent denticles but slightly longer; bears "comb-like" process, medial on inner side, extending at right angles to broad cusp surface. Denticles about 11 on each side of cusp, laterally compressed, fused to form sharp blade-like oral surface.

Remarks.—One specimen (not illustrated) has a vertical cusp symmetrically inserted

into bar. It is slightly rounded and does not bear "comb-like" process on inner face. This represent a distinct species or variety.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2915 (figured specimen) and 2916 (4 unfigured specimens).

ELSONELLA SECUNDA Youngquist, n. sp.
Plate 56, figure 4

Bar strongly arched, symmetrical, bearing very slight inner and outer lateral flanges, somewhat keel-like at both ends aborally. Cusp stout, somewhat rounded, confluent with, but slightly longer than denticles, inclined to general symmetry of unit. Denticles about 12 on each side of cusp, confluent except at very apices, may be very slightly rounded, form sharp blade-like oral surface.

Remarks.—Specimen figured is incomplete. Other fragmentary specimens preserve bar portion missing on this specimen and indicate a symmetrical arching of the bar as a whole. Differs from *E. prima* principally in the asymmetrical insertion of cusp and the slight rounding of a few denticles.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2917 (figured specimen) and 2918 (unfigured specimen).

EUPRIONIODINA? HAMULUS
Youngquist, n. sp.
Plate 56, figure 10

This specimen is represented only by the cusp. A fractured surface occurs at the posterior end of bar and several minute germ denticles (not illustrated) can be seen near the fracture upon careful microscopic study. Neither the cusp nor the base is bilaterally symmetrical. Cusp is bowed laterally, curved posteriorly, rounded in cross section, and tapers uniformly from base to apex. Length and slenderness of cusp is noteworthy and the affinities of this form with more nearly complete specimens, if such are found, should not be difficult to establish.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Holotype.—State Univ. Iowa, 2919.

EUPRIONIODINA STAUFFERI Youngquist, n. sp.
Plate 54, figures 5, 6

Bar thick, strongly keeled, somewhat laterally compressed posteriorly, bowed outward, moderately up-arched, with slight to strong medial lateral ridge on exterior side. Cusp inserted at crest of arch of bar. Aboral and inward deflection of bar extension, which is anterior to cusp, bears two or three deeply inserted short stout denticles. Cusp well developed, laterally compressed, strongly inclined forward. Denticles posterior to cusp about 8, deeply inserted, inclining somewhat forward in region of bar near cusp. Large denticles laterally compressed, small ones rounded.

Remarks.—Specimens illustrated are right and left individuals.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2920.

EUPRIONIODINA? UNGULA Youngquist, n. sp.
Plate 56, figure 7

Cusp long, stout, curved slightly inward and back, rounded on outer surface, flattened inside with moderately sharp edge formed at junction of inner and outer faces. Very small portions of bar preserved on type specimens; fractured surfaces suggest stout laterally compressed denticle-bearing posterior extension and anticusp or anteroinferior extension. Cusp and such germ denticles as are present set exceedingly deep in bar.

Remarks.—This species is known from two specimens each preserving only the cusp and very small portions of the bar. The great size of the single cusp relative to the size of complete specimens of other conodonts in the Middle Amana fauna is worthy of note. The affinities of this form with more nearly complete specimens, if such are found, should not be difficult to establish.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2921 (figured specimen) and 2922 (unfigured specimen).

EUPRIONIODINA OBTUSIDENS Youngquist, n. sp.
Plate 54, figure 1

Bar bowed outward posterior to cusp, slightly uparched, keeled, bearing median lateral ridge. Short extension of bar anterior to cusp deflected downward and outward, bearing two deeply inserted denticles. Denticles posterior to cusp about 8, blunt, not distinctly inserted in bar, not greatly different in texture from bar material, more or less confluent and grade into bar well above median lateral ridge. Cusp deeply inserted, relatively large, laterally compressed, inclined forward.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Holotype.—State Univ. Iowa, 2923.

EUPRIONIODINA? CUSPIDATUS Youngquist, n. sp.
Plate 54, figure 8

Anterior and posterior portions of bar about equal in length. Posterior portion somewhat compressed laterally, keeled, slightly bowed outward. Anterior portion deflected sharply downward, flexed outward, keeled, ends in blunt process. Cusp large, deeply inserted in bar with obvious multiple germ origin, flattened on outside, inner face bears median vertical ridge formed by angular junction of two halves of inner surface. Small process or bulge of bar at junction of this ridge. Five projecting denticles on posterior bar, slender, deeply inserted. Four or 5 slightly projecting denticles on anterior deflection of bar, deeply inserted. Posterior denticles and cusp inclined slightly inward.

Remarks.—The inward inclination of cusp can be observed from outside of bar. The inward inclination of the denticles can only be seen when the specimen is viewed on the inner surface.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2924 (figured specimen) and 2925 (unfigured specimen).

FALCODUS INCULTUS Stauffer
Plate 55, figure 14

Falcodus incultus Stauffer, 1938, Jour. Paleontology, vol. 12, p. 426, pl. 49, fig. 10.

Cusp somewhat more distinct than in Stauffer's specimen. All denticles and cusp slightly compressed laterally. Denticles appear to originate high in bar, confluent except in adoral fifth of their length. Apices of denticles rounded rather than sharp.

Occurrence.—Originally described from the type section of the Olentangy shale at Delaware, Ohio. Also occurs in Independence shale (?), Middle Amana, Iowa.

Plesiotype.—State Univ. Iowa, 2926.

HINDEODELLA DENTICULATA Youngquist, n. sp.
Plate 55, figure 2

Bar straight, long, with suggestion of lateral inward deflection just anterior to cusp. Denticles both anterior and posterior to cusp. Cusp rounded with slight lateral compression at base, diameter two or three times that of any denticle. Denticles originate deep in bar, projections may or may not be confluent, irregularly spaced, variable in size. Smaller denticles round in cross section,

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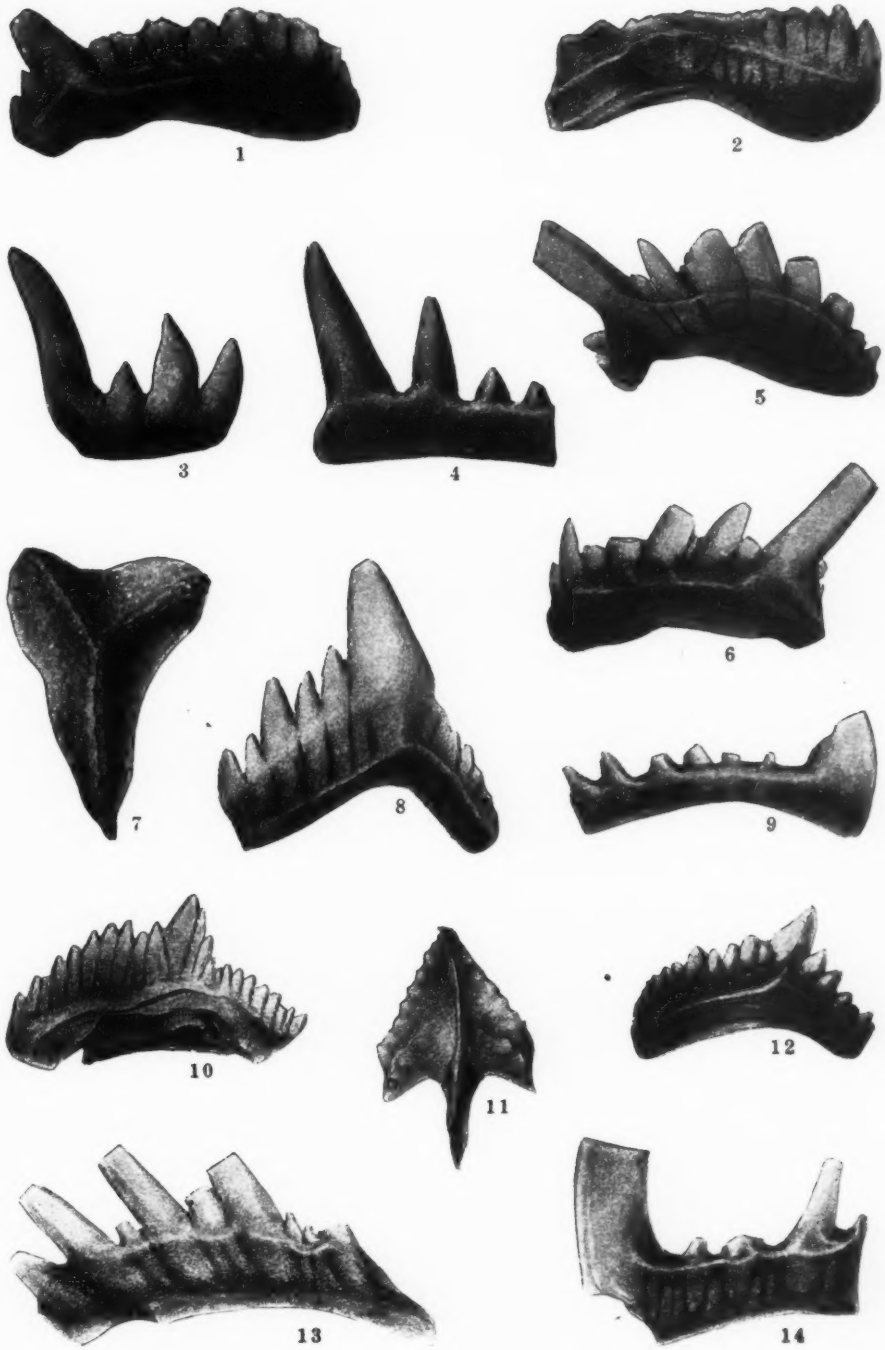
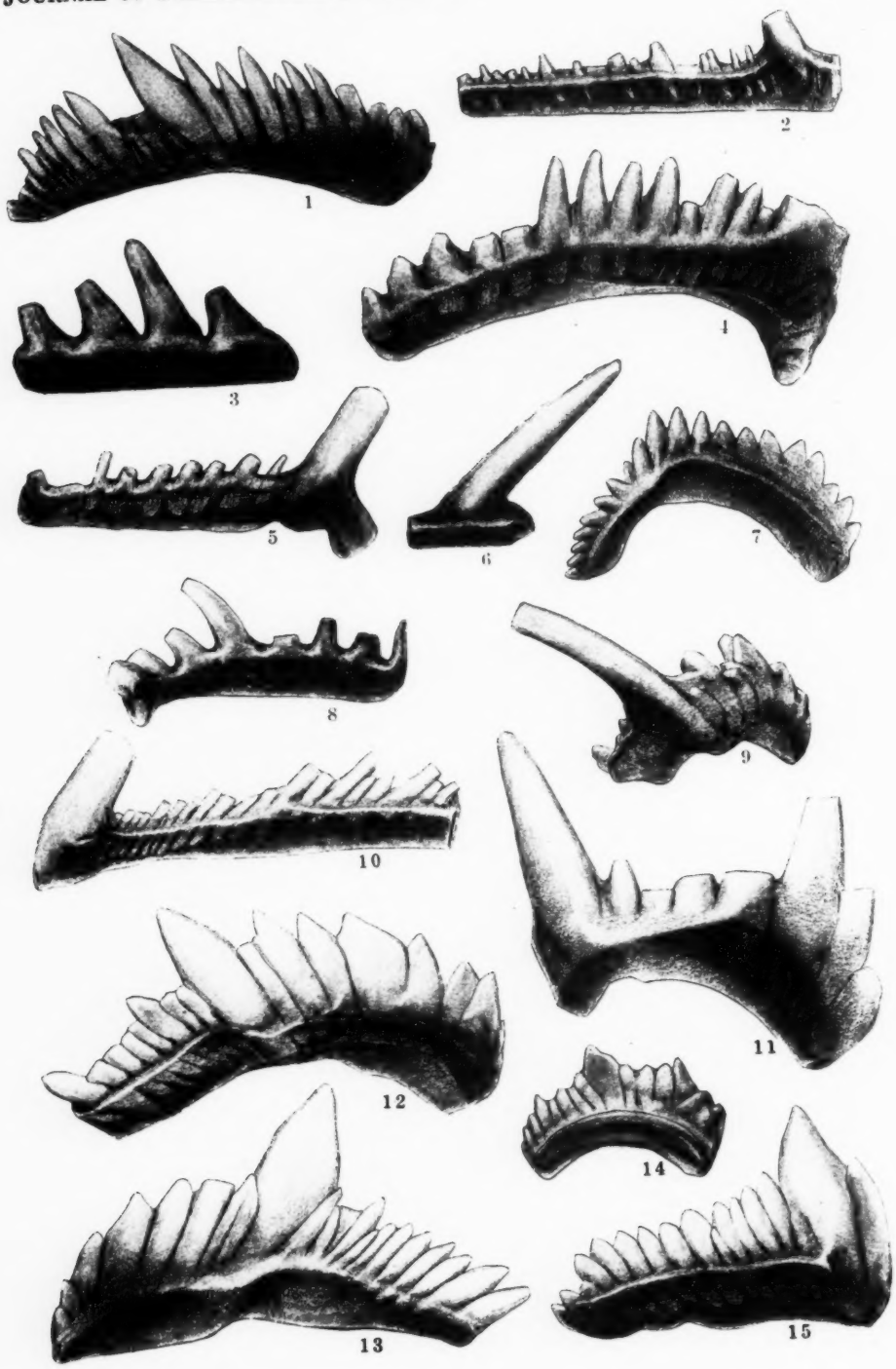
EXPLANATION OF PLATE 54

All specimens are from the Independence shale (?) 0.4 mile west of Middle Amana, Iowa; all figures are ×45.

FIGS. *1—Euprioniodina obtusidens*, n. sp. (p. 360)
2—Polygnathus angustidiscus, n. sp. (p. 365)
3—Ligonodina conulatus, n. sp. (p. 361)
4—Prioniodus sp. (p. 366)
5, 6—Euprioniodina staufferi, n. sp. (p. 359)
7—Ancyrognathus triangularis, n. sp. (p. 356)
8—Euprioniodina? cuspidatus, n. sp. (p. 360)
9—Prioniodus aff. *P. pinguis* Hibbard (p. 366)
10—Bryantodus argulus Stauffer (p. 357)
11—Ancyrodella buckeyensis Stauffer (p. 356)
12—Bryantodus amanaensis, n. sp. (p. 357)
13—Angulodus sp. (p. 357)
14—Prioniodus? masculus, n. sp. (p. 366)



Youngquist—Devonian Conodonts



Youngquist—Devonian Conodonts

larger ones may be somewhat compressed laterally. Bar somewhat rounded but has distinct shoulder formed by lateral expansion of oral surface.

Remarks.—This species resembles *H. lambtonensis* Stauffer from the Olentangy but differs in that its denticles are generally not confluent as they emerge from the bar and there is no obvious alternation of large and small denticles.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2927 (figured specimen) and 2928 (unfigured specimen).

HINDEODELLA LAMBTONENSIS Stauffer
Plate 55, figure 10

Hindeodella lambtonensis Stauffer, 1938, Jour. Paleontology, vol. 12, p. 428, pl. 50, figs. 2, 5, 8, 13, 14, 17, 20, 25, 28, 31.

Bar elongate, very slightly bowed. Anterior limb, as noted by Stauffer, wanting on most specimens but when found shows tendency to curve aborally and inward.

Occurrence.—Originally described from Olentangy shale at Delaware, Ohio. Also occurs in Independence shale (?), Middle Amana, Iowa.

Plesiotype.—State Univ. Iowa, 2929.

LIGONODINA CONULATUS Youngquist, n. sp.
Plate 54, figure 3

Bar not well developed, denticles and cusp fused at base forming most of "bar" except for small basal expression of amber-colored bar-like material. Cusp rounded but with sharpened posterior and anterior edges, incurved, inclined slightly forward, tapering smoothly from base to tip. Anterior side of base of cusp with shallow depression. Denticles, 3, short, cone-shaped, incurved.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Holotype.—State Univ. Iowa, 2930.

LIGONODINA FALX Youngquist, n. sp.
Plate 55, figure 9

Cusp long, slender, gently curved posteriorly, nearly round in cross section, inclined to bar at high angle, Anterioinferior portion of bar proper turned sharply back in same horizontal plane as posterior portion of bar but aboral side bears strong keel projecting sharply downward. Anteroinferior portion of bar much heavier than posterior portion, bears 5 or 6 relatively stout denticles curving inward, concave to cusp. Posterior bar much thinner than anterior, apparently incomplete on all specimens, bears at least 3 small rounded denticles inserted almost normal to bar. All denticles and cusp originate deep in bar—best seen on inner side of specimen. Some germ denticles present, scattered irregularly throughout length of bar.

Remarks.—This species closely resembles *L. recurvata* Branson and Mehl from the Grassy Creek shale of Missouri but differs in the lack of sharp anterior and posterior edges from midlength on cusp to terminus. Also the inward flexing of the anteroinferior portion of bar is more acute.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

EXPLANATION OF PLATE 55

All specimens are from the Independence shale (?) 0.4 mile west of Middle Amana, Iowa; all figures are ×45.

FIGS. *1*—*Ctenognathus falcatus* Stauffer (p. 358)
2—*Hindeodella denticulata*, n. sp. (p. 360)
3—*Lonchodus* sp. (p. 362)
4—*Prioniodus bellulus*, n. sp. (p. 365)
5—*Prioniodus?* sp. (p. 366)
6—*Oistodus?* sp. (p. 364)
7—*Nothognathella iowaensis*, n. sp. (p. 363)
8—*Prioniodella?* sp. (p. 365)
9—*Ligonodina falx*, n. sp. (p. 361)
10—*Hindeodella lambtonensis* Stauffer (p. 361)
11—*Prioniodus? peculiaris*, n. sp. (p. 366)
12, 13—*Bryantodus chesteri*, n. sp. (p. 357)
14—*Falcodus incultus* Stauffer (p. 360)
15—*Bryantodus inequalis* Branson and Mehl (p. 358)

Syntypes.—State Univ. Iowa, 2938 (figured specimen) and 2939 (3 unfigured specimens).

LIGONODINA LONGIROSTRIS Youngquist, n. sp.
Plate 56 figure 8

Cusp stout, probably fairly long, slightly recurved, subrounded. Anterioinferior process deflected downward and backward, compressed laterally to form aboral keel. Denticles about five, discrete, recurved inward and backward, varying in size with larger ones near cusp. Width and height of posterior bar about equal. Aboral side of bar slightly excavated beneath insertion of cusp. Slight keel present aborally, developing posteriorly. Denticles of posterior bar variable in size, deeply inserted. Two to five germ denticles in bar between neighboring emergent posterior denticles

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2933 (figured specimen) and 2934 (3 unfigured specimens).

LONCHODINA ANGUSTIDENS Youngquist, n. sp.
Plate 56 figure 9

Bar bent in two directions, upward and outward. Ends of bar curved inward, about equal in length, posterior portion slightly shorter. Anterior portion compressed laterally, strongly keeled; posterior portion less compressed, only slightly keeled. Cusp distinct, needle-like, deeply inserted, curved posteriorly, curved or inclined very slightly inward. Denticles discrete, all curve posteriorly, needle-like, becoming slightly stouter near anterior end of series, 6 to 8 anterior to cusp inserted higher in bar than 5 to 7 on posterior part of bar.

Remarks.—The type specimens show remarkable agreement in structure considering their complexity and exhibit little variation.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2931 (figured specimen) and 2932 (unfigured specimen).

LONCHODINA? PARIDENS Youngquist, n. sp.
Plate 56, figure 6

Bar very strongly arched, slightly bowed, thick orally, tapering to thin, almost keel-like edge aborally. Inside lateral surface very smooth, slightly concave. A median denticle divides unit into nearly symmetrical halves. Oral surface of bar bears five prominent thick rounded inwardly curved denticles. The two most prominent denticles on each of half bar curve, inwardly slightly concave toward median denticle. Eight lesser denticles irregular located, short, rounded. All denticles inserted well into bar.

Remarks.—This species is especially characterized by its almost perfect bilateral symmetry and unusually large size. No closely related form appears to have been illustrated previously and the generic affinities are uncertain.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Holotype.—State Univ. Iowa, 2937.

LONCHODUS sp.
Plate 55, figure 3

Denticles moderately slender, somewhat rounded in cross section near tips, laterally compressed toward base, not distinctly set in bar but grading texturally into base. Base slightly convex orally and aborally, bearing slight lateral ridge more aboral than median.

Remarks.—Pander described this genus as having slender pointed denticles occurring in a uniform series or alternating with smaller denticles, all originating in a horizontal or convex base. This definition seems to apply to a great many conodont forms and fractured or fragmented specimens properly belonging to other genera may be indistinguishable from *Lonchodus*. As a result this genus has become somewhat of a taxonomic "catch-all" and undoubtedly includes many unrelated specimens. Because of its definition the genus could hardly fail to have a long range, and its members in general have little stratigraphic value.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Repository.—State Univ. Iowa, 2935 (figured specimen) and 2936 (unfigured specimen).

Genus MEHLINA Youngquist, n. gen.

Compound blade-like units, bowed or straight, strongly compressed laterally. Anterior half of aboral margin extends downward relative to posterior up-arched half. Angle of junction of posterior and anterior trends of aboral margin clearly marked by obtuse angle. No aboral excavation or escutcheon present. Denticles may be rounded or laterally compressed, invariably sheathed except for small adoral portions. Denticles originate high in bar at both ends but points of origin becomes progressively lower medially. Slender germ denticles generally present in bar near base of denticle insertion. Denticles relatively uniform in size or variable.

Remarks.—This genus resembles *Spathognathodus* Branson and Mehl but differs in the absence of an escutcheon or navel. Also the oral surface is made up of projecting nonsheathed denticles rather than germ denticles completely sheathed.

Occurrence.—Both of the known representatives of this genus occur in the Independence shale (?).

Genotype.—*M. irregularis*, n. sp.

MEHLINA IRREGULARIS Youngquist, n. sp.
Plate 56, figure 2

Bar blade-like, strongly compressed laterally, very slightly bowed. Apical surface typically composed of 20 to 24 denticles which vary in size, particularly in sheathed portions where axes of growth are somewhat irregular. Larger denticles compressed laterally.

Remarks.—The irregular denticles mark this species as being one end of an essentially complete gradation from specimens with distinctly irregular denticles to others with uniform denticles, or denticles varying in size in a gradational series. *M. gradatus*, n. sp. is a form with nearly uniform denticles. Although a complete gradation from irregularly to uniformly denticulated specimens can be found most forms clearly fall into one group or the other.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2940 (figured specimen) and 2941 (3 unfigured specimens).

MEHLINA GRADATUS Youngquist, n. sp.
Plate 56, figure 3

Bar blade-like, strongly compressed laterally, slightly bowed. Most denticles rounded, essentially uniform in length, those at midpoint in series tend to be more slender than others both posteriorly and anteriorly. Growth of denticles more uniform than in *M. irregularis*. Germ denticles fewer. Twenty to 22 denticles project from oral surface.

Remarks.—This species is the opposite extreme of *M. irregularis*. Denticles are essentially uniform with only moderate and gradational variations.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2942 (figured specimen) and 2943 (unfigured specimen).

NOTHOGNATHELLA IOWAENSIS Youngquist, n. sp.
Plate 55, figure 7

Posterior blade slender, about as wide as deep, bearing 8 to 10 short stout denticles confluent at their bases. Small nodose flange on outer side of posterior bar; slightly larger flange on inner side. Anterior blade moderately offset laterally from posterior blade, bears 10 to 12 denticles which are broader, longer, more confluent, more laterally compressed than posterior denticles. Aboral keel on anterior bar becomes progressively more prominent anteriorly; no lateral nodose flange on either inner or outer side. Unit curved in two directions—both arched and bowed.

Remarks.—The several specimens assigned to this species differ slightly among themselves. An outer nodose flange on the posterior bar is not present on all, and at best it is not well developed. An inner flange is always present but varies considerably in size. Posterior denticles are usually similar to those on the figured specimen; anterior denticles may be more prominent with 2 or 3 particularly tall ones just anterior to junction of posterior and anterior bars. These variations might be interpreted as functions of the degree of maturity but this is not probable because the specimens are of nearly equal size.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2944 (figured specimen) and 2945 (5 unfigured specimens).

OISTODUS? sp.
Plate 55, figure 6

Cusp and base bilaterally symmetrical. Growth axis of cusp straight, inclined to base at about 45 degrees. Cusp essentially round in cross section, tapering uniformly from base to tip. Base distinctly set off from cusp, subrectangular in cross section except for shallow median aboral groove. Cusp with slight median ridge on anterior surface irregularly indented from base to tip.

Remarks.—As noted by Furnish, typical distacodid teeth are not commonly found in conodont faunas younger than Lower Ordovician and very few genera have been proposed since Pander's work of 1856. This specimen does not show evidence of being part of a compound tooth and is accordingly referred with question to an Ordovician genus. It bears only a slight resemblance to *O. abundans* Branson and Mehl. It is, of course, possible that older formations yielding the sediments making up the Independence shale (?) may have contributed this specimen which could have been transported and redeposited without damage.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Repository.—State Univ. Iowa, 2946.

PALMATOLEPIS FLABELLIFORMIS Stauffer
Plate 56, figure 1

Palmatolepis flabelliformis Stauffer, 1938, Jour. Paleontology, vol. 12, p. 436, pl. 53, figs. 2, 4, 9, 12, 14.

Arrangement of numerous nodes on oral surface and size variable but pronounced specific features make identification easy.

Remarks.—*Palmatolepis* has been recorded by Branson and Mehl from the Grassy Creek shale of Missouri, by Ulrich and Bassler from the Chattanooga shale of Alabama and the Hardin sandstone of Tennessee, and by others from various Upper Devonian and Lower Mississippian formations. The abundance of a representative of this genus in the Independence shale (?) indicates strongly that it is Upper Devonian in age.

Occurrence.—Originally described by Stauffer from the Olentangy shale of central Ohio. Specimens abundant in Independence shale (?), Middle Amana, Iowa.

Plesiotype.—State Univ. Iowa, 2947 (figured specimen) and 2948) 5 unfigured specimens).

PALMATOLEPIS FOLIACEUS, Youngquist, n. sp.
Plate 56, figures 11, 12

Plate narrow relative to length, thin, convex orally, moderately undulating on broad side, not as convex and only slightly undulating on narrow side. Surface relatively smooth but bears numerous small nodes. Carina originates as rough low ridge without distinct denticles near posterior end of plate, passes forward curving slightly toward broad portion to azygous node, beyond which it consists of 3 to 6 nodes becoming progressively more denticuloid anteriorly, grading into series of 6 to 10 denticles, with slight curvature in other direction but soon becomes essentially straight grading into blade. Aboral surface of plate essentially

EXPLANATION OF PLATE 56

All specimens are from the Independence shale (?) 0.4 mile west of Middle Amana, Iowa; all figures are ×45.

FIGS. *1*—*Palmatolepis flabelliformis* Stauffer (p. 364)
2—*Mehlina irregularis*, n. sp. (p. 363)
3—*Mehlina gradatus*, n. sp. (p. 363)
4—*Elsonella secunda*, n. sp. (p. 359)
5—*Elsonella prima*, n. sp. (p. 358)
6—*Lonchodina? paridens*, n. sp. (p. 362)
7—*Euprioniodina? ungula*, n. sp. (p. 359)
8—*Ligonodina longirostris*, n. sp. (p. 362)
9—*Lonchodina angustidens*, n. sp. (p. 362)
10—*Euprioniodina? hamulus*, n. sp. (p. 359)
11, 12—*Palmatolepis foliaceus*, n. sp. (p. 364)
13, 14—*Prioniodus basilicus*, n. sp. (p. 365)

Youngquist—Devonian Conodonts

smooth, bearing only small escutcheon directly beneath azygous node.

Remarks.—Specimens figured are paired, right and left, coming obviously from bilaterally symmetrical animals.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2949 (figured specimens) and 2950 (unfigured specimen).

POLYGNATHUS ANGUSTIDISCUS
Youngquist, n. sp.
Plate 54, figure 2

Blade predominant, plate about one-fourth of entire length, plate slightly concave orally, rounded aborally, slightly plicated with crenulate oral edge. Blade forms crenulate ridge orally apparently composed of denticles visible with transmitted light, only anterior 2 or 3 projecting from sheath.

Remarks.—These specimens may represent a primitive form of the polygnathoid type. Only a small plate is represented and the blade predominates. If the escutcheon of a blade-like form such as *Spathognathodus* Branson and Mehl migrated vertically to the oral side and became concave on the oral rather than on the aboral side, a form very similar to this would result. Or such a plate might have originated by the lateral expansion of the adoral region of the blade. One unfigured representative of *Mehlina irregularis*, n. sp. shows a slight node on the blade at approximately the position of the plate of *P. angustidiscus*.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2951 (figured specimen) and 2952 (2 unfigured specimens).

PRIONIODELLA? sp.
Plate 55, figure 8

Base bar-like, with 8 denticles mostly inclined posteriorly. Anterior denticles apparently of same translucent amber colored material as bar. Posterior portion of bar curved, trending about at right angles to anterior, bearing 2 distinctly inserted denticles apparently differing in composition from base.

Remarks.—This form is known from only one incomplete specimen. Its generic affinities are doubtful and it probably represents a new species.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Repository.—State Univ. Iowa, 2953.

PRIONIODUS BASILICUS
Youngquist, n. sp.
Plate 56, figures 13, 14

Bar slightly arched, keeled posteriorly, somewhat compressed laterally. Projecting denticles usually discrete, 6 to 9, commonly 7, deeply set, variable in size. Larger denticles slightly compressed laterally, smaller ones rounded. Germ denticles numerous, one or two generally separate projecting denticles. Cusp prominent, oval in cross section. Anticusp blunt or moderately sharp-pointed, may be flexed slightly outward, with 4 or 5 germ denticles not distinctly projecting but crenulating anticusp margin.

Remarks.—This form resembles *P. bownockeri* Stauffer from the Olentangy but differs slightly in that its cusp is not sharp-edged and may be nearly round. Specimens illustrated are right and left units.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2954 (figured specimens) and 2955 (5 unfigured specimens).

PRIONIODUS BELLULUS
Youngquist, n. sp.
Plate 55, figure 4

Bar slightly bowed outward, up-arched, keeled, compressed laterally especially toward anterior region, bearing 10 to 12 denticles deeply inserted. Cusp large, flattened, with sharp anterior edge continuing aborally as an anticusp. Anticusp deflected outwardly, with sharp anterior and posterior edges. Anterior half contains 4 to 6 unprojecting denticles rising far enough to crenulate edge. Denticles slender, inclined slightly forward in anterior portion of bar; somewhat longer, more nearly erect at mid-length; stubby in posterior portion.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Holotype.—State Univ. Iowa, 2956.

PRIONIODUS? MASCULUS
Youngquist, n. sp.
Plate 54 figure 14

Bar straight, nearly square in cross section, may be slightly rounded with aboral convexity. Cusp stout, rising almost perpendicular to bar, curved slightly backward, may be rounded in cross section but tends toward squareness. Denticles discrete, rounded, inclined posteriorly, considerably more slender than cusp, originating well down in bar near aboral edge. Two to 5 slender germ denticles present between the bases of adjacent projecting denticles.

Remarks.—This species is represented by 5 specimens all of which are apparently incomplete and broken in almost exactly the same manner. The length of the bar posterior to the cusp is unknown; longest specimens preserve 6 to 8 projecting denticles. The anterior end of bar fractured at cusp (as illustrated) is common to all and may indicate a structural weakness of the unit at this point perhaps caused by a diverging anticusp or anterior deflection of bar. Specimens are chiefly characterized by the stoutness and squareness of their cusps and their neatly and deeply inserted denticles.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Syntypes.—State Univ. Iowa, 2957 (figured specimen) and 2958 (4 unfigured specimens).

PRIONIODUS? PECULIARIS
Youngquist, n. sp.
Plate 55, figure 11

Bar strongly keeled posteriorly, up-arched, slightly sinuous, bearing median lateral ridge which becomes progressively more pronounced anteriorly. Cusp large, round in cross section, extends forward, continues aborally on its anterior side in form of small anticusp bearing a distinct but unprojecting denticle. Denticles about 7, unequal in size, distinctly inserted, rounded, many with small germ denticles near their base of insertion in bar. Preserved portions of fourth and fifth posterior denticles suggest they rival cusp in size.

Remarks.—This exceptionally large specimen is probably complete except for the denticles. This form does not fit well in any present classification and is tentatively placed in the genus *Prioniodus* because of the presence of a slight anticusp.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Holotype.—State Univ. Iowa, 2959.

PRIONIODUS aff. P. PINGUIS Hibbard
Plate 54, figure 9

Bar somewhat flattened by oral-aboral compression, rather thick, up-arched adorally. Cusp stout, projecting downward only slightly without producing distinct anticusp. Denticles distinctly separated, rounded, inclined rather than curved posteriorly.

Remarks.—This form resembles *P. pinguis* Hibbard and similar forms from the Portage group of western New York. The lack of a distinct anticusp, however, is an obvious difference.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Repository.—State Univ. Iowa, 2960.

PRIONIODUS sp.
Plate 54, figure 4

Bar rounded but with distinct squareness in cross section. Cusp rounded, with evident anterior and posterior edges, tapering smoothly from base to tip. Denticles rounded becoming progressively shorter posteriorly. Specimen may be incomplete.

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Repository.—State Univ. Iowa, 2961.

PRIONIODUS? sp.
Plate 55, figure 5

Bar slender, bearing slight ridge aborally, triangular excavation well developed on aboral surface beneath insertion of cusp at base of which short stout cone-shaped inward extension of the par projects on inner side perpendicular to long axes of bar and cusp. Anterior bar short, deflected downward. Cusp rounded on outer surface, grooved medianly on inner surface, inclined inward and slightly forward. Posterior bar bears 8 inserted denticles, rounded in cross section, inwardly inclined.

Remarks.—Presence of short cone-shaped inward extension of bar is worthy of note. This feature cannot be observed from the

outer side of the specimen (as illustrated).

Occurrence.—Independence shale (?), Middle Amana, Iowa.

Repository.—State Univ. Iowa, 2962.

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MANUSCRIPT RECEIVED JUNE 17, 1943.

JOURNAL OF PALEONTOLOGY, VOL. 19, NO. 4, PP. 368–375, PL. 57, 3 TEXT FIGS., JULY 1945

MOULT STAGES OF THE PENNSYLVANIAN OSTRACODE ECTODEMITES PLUMMERI

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ABSTRACT—A method for the study of fossil ostracode moult stages, involving the plotting of length-height dimensions on rectangular coordinate paper, has shown that the various instars align themselves into distinct groups which form a straight line. The rate of growth for this species has been reduced to an equation by conventional statistical methods and the details of the various instars represented are described and illustrated.

THE DETAILS of the moulting of ostracodes has received little attention, even among those doing research on modern fresh-water and marine forms. As a result, there are few references to moulting in general, and data on the number of instars and the relative time required for the development of a mature ostracode are extremely scarce. From data secured from field collections and from animals reared in the laboratory (on fresh-water ostracodes), it has been observed that the ontogenetic development is similar for different species (Hoff, 1942, p. 35). During development, 9 instars, including the mature animal, are known to occur. Differences of sculpturing and of color of the shells of various instars have been noted. Claus (1901) found great differences between young and old shells and showed that the young of *Cypris labiata* lacks the lip-like expansion of the anterior margin as found in the adult and that the latter does not possess the row of small denticles along the posterior margin found in the young. Alm (1916, pl. 1) showed shell changes in several species common in Sweden.

Kellett in 1929 (p. 197) described the small unfrilled form of the Pennsylvanian *Hollinella* as the young of some species. The same author later (1943, p. 616) recognized as many as six moults in Permian representatives of the Kirkbyidae and the Kloedenellidae.

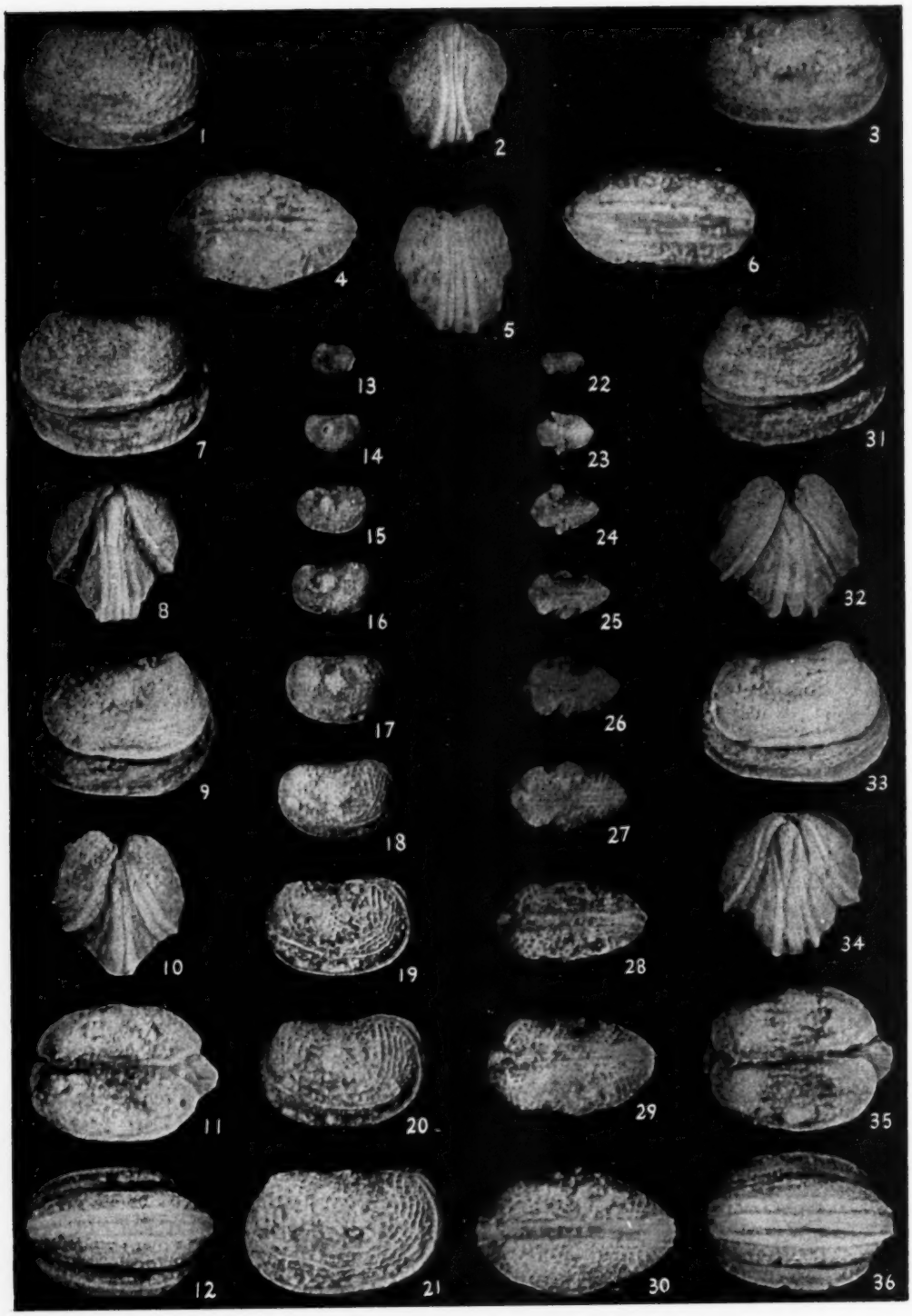
LeRoy (1945) has shown, I believe for the first time, the details of the various parts of shells representing the known instars of fossil ostracodes. He recognized that structural differences between early and late moults are considerable and are reflected in size and shape of the valve, hinge structure, ornamentation, muscle scar pattern, marginal areas, and pore canal systems.

He described and illustrated the various moult stages of *Cythereis simiensis* (LeRoy) from the "Middle Pliocene" San Diego formation of California, and *C. holmani* LeRoy of the Miocene from east coastal area of central Sumatra.

During the examination of several samples of microfossil material collected and loaned by Mrs. Helen J. Plummer from the lower Marble Falls formation of Texas, a number of specimens of *Ectodemites*[1] were found to have smaller shells attached to them in such a manner that the hinges of the two forms coalesced. After this discovery, the sample was carefully picked of all normal two-valved specimens of this genus, and a number of individuals varying in size from about one-eighth to three-fourths of a millimeter in length were obtained (pl. 57, figs. 7–24). These were arranged in nine groups of specimens, each of uniform size. The length and height were measured and when these dimensions were plotted on coordinate paper, it was found that no specimen of one group fell within the range of any other, either in length or height (fig. 1). It was also found that the mean of all points lie close to a straight line which passes through the zero point. The fact that all of the points are not exactly on this line can be attributed to error in establishing a true mean because too few specimens were measured.

The moulting of the members belonging

[1] This species has since been described as *Ectodemites plummeri* Cooper (1945).



Cooper—Ostracode Moult Study

to the various classes and orders of the phylum Arthropoda is too well known to require detailed comment. Brooks (1886) found that the larva of *Squilla* increased a quarter of its own length at each moult and later Dyar (1896) declared that caterpillars grow from instar to instar by geometrical progression. Insects grow at a rate consistent with Dyar's or Brook's law. Przibram (1939) stated that an insect moults when the number of cells in the larval body has approximately doubled. If that is so, each instar should weigh twice as much as the preceding one and each linear dimension therefore should theoretically increase by $3\sqrt{2}$ or 1.26 times, a figure close to Brooke's first estimate (Thompson 1942, p. 165).

Huxley (1923, pp. 4–8) has shown that where the ratio of the relative rates of growth of various parts of an animal remain constant, there is a constant differential growth ratio, denoted by the value of k in the following formula:

$$Y=a+bX^k$$

In this formula Y and X represent the size (or weight) of two relative parts of an animal. a is the value of Y when X is zero, b is the slope of the line (tangent α) or zoologically the basic ratio of the absolute sizes of the increments of Y and X or is equal to the ratio of their arithmetic growth rates (Simpson and Roe, 1939, p. 355).

If $a=0$ then the formula becomes

$$Y=bX^k$$

This formula is based upon the following assumptions:

1. That for the range over which the formula holds, the growth-rate of any part relative to the growth rate of the body remains constant.

2. Growth is a process of self-multiplication of living substance,—that the rate of growth of an organism growing equally in all its parts is at any moment proportional to the size of the organism.

3. Self-multiplication slows down growth with increasing age or size.

CALCULATION OF $H=bL^k$ FOR LENGTH AND HEIGHT OF CARAPACE OF *Ectodemites plummeri*

Instar	L (Length, μ)	H (Height, μ)	Logarithms					
			L	H	d_L	d_H	d_Ld_H	d_L^2
M-8	168.7	112.5	2.227	2.051	−0.330	−0.320	0.09560	0.10890
M-7	206.2	137.5	2.314	2.138	−0.213	−0.223	0.04750	0.04537
M-6	253.1	162.5	2.403	2.210	−0.154	−0.161	0.02479	0.02372
M-5	300.0	192.5	2.477	2.284	−0.080	−0.087	0.00696	0.00640
M-4	368.7	243.7	2.567	2.387	+0.010	+0.016	0.00016	0.00010
M-3	446.9	281.2	2.650	2.449	+0.111	+0.078	0.00866	0.01232
M-2	531.2	337.5	2.725	2.528	+0.168	+0.157	0.02637	0.02822
M-1	618.7	400.0	2.791	2.602	+0.234	+0.231	0.05405	0.05476
			2.860	2.688			0.09605	0.09181
M	725.0	465.7	23.014	21.337	+0.303	+0.317	0.36014	0.37160

$M_L=2.557$ $M_H=2.371$

$$K=\frac{d_Ld_H}{d_L^2}=\frac{0.36014}{0.37160}=0.969.$$

EXPLANATION OF PLATE 57

FIGS. *1–6*—Right valve, anterior end, left valve, posterior end, dorsal, and central views of a normal mature carapace.

7–12; 31–36—Two mature specimens (figs. 7 and 31) with the next to last moult (M-1) attached along hinge line. Views are shown in same order as in figures 1–6.

13–30—Dorsal and lateral views of a moult series from the adult (M, figs. 21, 30) to the smallest known instar (M-8, figs. 13–22). The latter is probably the first carapace developed. Note the spine-like node developed by the second moult (M-7) which gradually thickens and becomes less conspicuous in the next four moults, and finally has disappeared as a node on the three final instars (M, M-1, M-2). Thus all except these last three instars would be considered *Amphissites* because of the characteristic medial node of this genus.

4. Growth is effected by external environment—by temperature and nutrition.

Therefore the growth-rate of any particular organism is proportional to (a) a characteristic of the part in question, (b) the size of the part, and (c) to a general factor dependent on age and environment which is the same for all parts of the body.

$$M_L=2.557 \qquad M_H=2.371$$

$$k=\frac{d_L d_H}{d_L^2}=\frac{0.36014}{0.37160}=0.969.$$

A shorter, but more approximate, method of finding k can be used since a straight line is determined by any two points. Using two sets of values of L and H then

$$k=\frac{\log H_t-\log H_o}{\log L_t-\log L_o}.$$

where H_t is a high value and H_0 a lower value and L_t and L_0 are corresponding values for the length. The more specimens making up the above equations the more accurate k will be. The estimate is also better, if values for H_t and H_0 are chosen for moults far apart. Using the values for M and M-8

$$k=\frac{2.660-2.044}{2.860-2.227}=\frac{.616}{.633}=.973$$

which differs from the value obtained by the method of least squares by only 0.4 per cent. The line passes through the means of the logarithms so

$$M \log H=\log b+.969\times 2.557$$
$$2.371=\log b+.969\times 2.557$$
$$\log b=9.884-10$$
$$b=0.765$$

The equation therefore for the growth of *E. plummeri* becomes

$$H=0.765L^{.969}$$

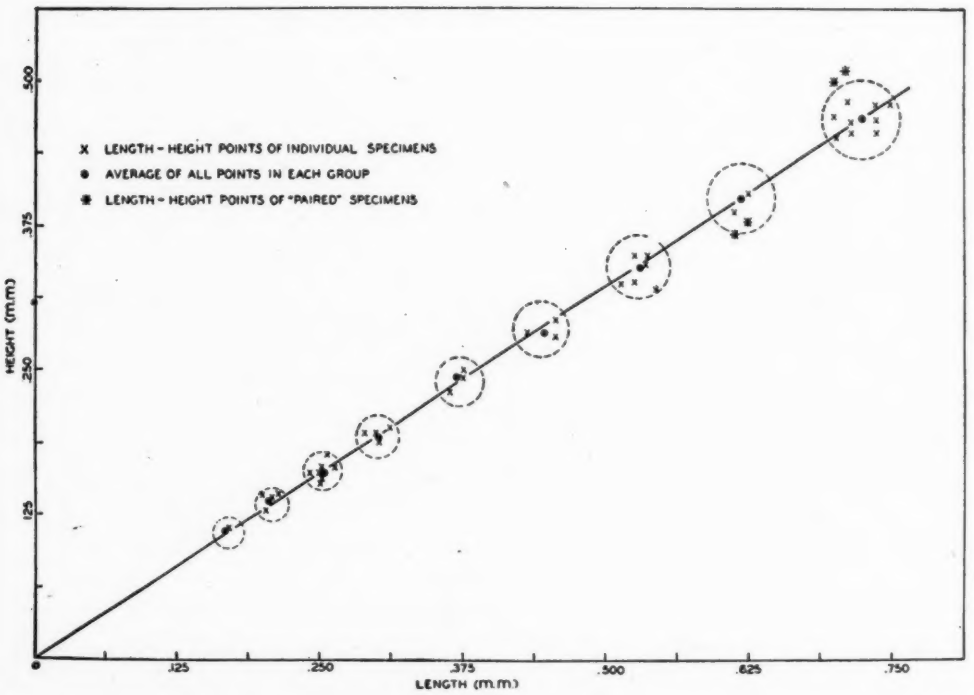


FIG. 1—Graph drawn through median points of length-height measurements of normal specimens of *Ectodemites plummeri*. Also shown (*) are the measurements of the shells of the two paired specimens shown in plate 57, figures *7–12; 31–36*.

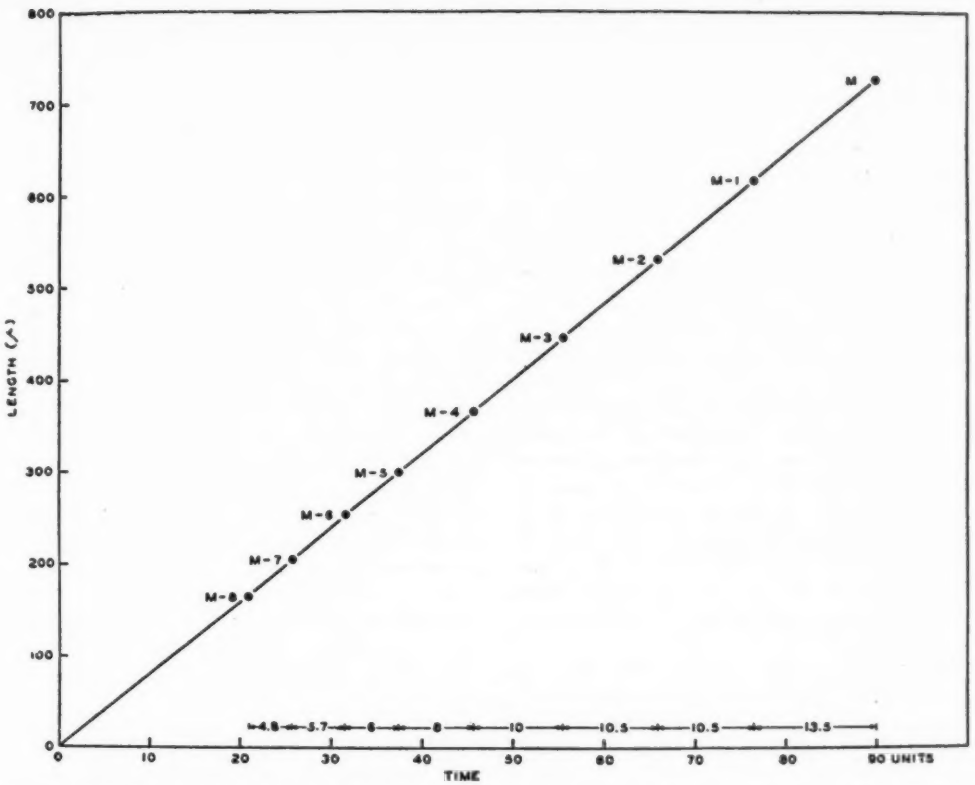


FIG. 2—Graph showing the relative time between moults, assuming a uniform growth rate. In constructing the graph it was assumed that 90 units of time were required to produce the 9 moults which culminated in the mature instar, thus fixing its point on the length-time curve. A straight line was then drawn to the 0 point and the other points were located on the line according to their respective lengths (heights would have served equally as well). The points were projected to the time axis and the number of units between instars measured, as indicated. If it is assumed that the ostracode required 90 days to reach maturity, then the interval between each instar corresponds to one day.

The theoretical values of H for the observed values of L are shown in the following table:

CALCULATION OF THEORETICAL VALUES OF H

Instar	0.969 (log L)	Col. 1 + log b	$H(\mu)$*
M-8	2.160	2.044	110.7
M-7	2.245	2.129	134.6
M-6	2.331	2.215	164.1
M-5	2.403	2.287	193.7
M-4	2.492	2.375	237.7
M-3	2.581	2.465	291.8
M-2	2.643	2.527	336.6
M-1	2.717	2.601	399.1
M	2.776	2.660	458.1

* Check with third column of preceding table which gives the measured values for H.

Probably even less is known about the interval between instars of fossil ostracodes than about other moulting details. Kellett's observation of six instars gives no certainty that others were not present. With one exception the space between instars on the graph (fig. 1) increases at each moult, the interval between the M-7 and M-6 is equal to that between the M-6 and M-5. The space between the smallest instar (M-8) and the zero point is approximately 2½ times the average interval between instars; thus giving ample space for other instars. However, since the size of the instar hatched from the egg is unknown, it cannot be definitely stated that any instars belong in this interval.

However, an idea of the relative elapsed time between instars can be gained by assuming that the adult was produced at the end of a definite period of time equals 90 units (an average of 10 for each instar). Then by plotting time on the ordinate and length (or height) on the abscissa, the time interval between instars can be determined in terms of the total time required to produce the mature individual (fig. 2). A line is drawn joining the zero point with the instar. The remaining instars are located on the line according to their length (or height) and the projection of these points to the horizontal coordinate will give the interval of elapsed time between each instar in terms of the time required to produce the adult. This is based on the assumption that the rate of growth was uniform (which probably was not the case). However, this is probably as close as workers with fossil material will ever be able to come. Many living ostracodes pass through their moult cycle in about three months, hence if the analogy is carried to the fossils, the values obtained from figure 2 closely approximate days, assuming of course uniform ecological conditions.

The rate of growth of this ostracode between moults was not uniform as shown by the variable spacings of points on the graphs (figs. 1 and 2). Other shell features vary considerably between the smallest known instar and the mature shell. The development of a spine into a node and its degeneration into a slight protuberance or swelling on the mature individual is pointed out in the plate explanation. Other features such as thickness, detailed surface ornamentation, hingeline, and configuration of shell outline all undergo marked changes from moult to moult.

The recognition of these intermediate stages in the development of ostracode shells from the nauplius to the adult is of utmost importance in taxonomy, because in many cases species, and sometimes genera, have been based upon type specimens that are immature, resulting in considerable confusion and needless duplication of names. A notable example is that of *Hollinella* Coryell (1928, p. 377) based upon an immature specimen from the Pennsylvanian of Texas. The various instars of *Sulcella sulcata*, Coryell and Sample (1932, p. 275) have been described under no less than five species and, in some cases, as two different species by the same authors.

A detailed description of the instars, beginning with the youngest, will facilitate the tracing of the changes undergone by the various shell features from moult to moult.

Nauplius M-8—Thickness, 0.0875 mm. Anterior node small and rounded, but prominent. No spines or medial nodes. Surface smooth except for very fine pits, but no carina present; hinge line straight.

Instar M-7—Thickness, 0.113 mm. Anterior node small and less prominent than M-8. Medial node 0.45L[2] from anterior end, long, broad and flaring at base, upper part abruptly constricted to form an elongate needle-like spine directed sharply forward. Surface smooth except for a few relatively large, polygonal pits. Outline distinctly asymmetrical, greatest height 0.35L from posterior end. Hinge line straight to slightly concave upward, shells meet without overlap around free margins. A rudimentary carina is present around medial portion of free margin, extending part way around posterior margin.

Instar M-6—Thickness, 0.132 mm. Anterior node rather prominent. Medial node nearly central (0.43L from anterior end), relatively short, and rounded, lacking the spine-like termination of M-7. Surface pits large, polygonal in upper part of shell and without orderly arrangement, slightly smaller in lower half tending toward alignment parallel to carina bordering free margins. Carina longer, more prominent than that in M-7. Greatest height 0.29L from posterior end. Hinge straight.

Instar M-5—Thickness 0.162 mm. anterior node elongate downward tending to form anterior shoulder rather than node. Carina smooth, prominent, extending from posterodorsal angle around posterior and ventral margins to anteroventral angle. Some specimens show beginnings of secondary or inner carina. Medial node relatively large in diameter, low, nearly central. Hinge line straight, but dorsal outline somewhat concave due to swelling of anterior shoulder slightly above hinge. Surface pits large, polygonal, no kirkbyan pit discernible.

[2] Equals 0.45 of total length of carapace.

Instar M-4—Thickness 0.237 mm. Antetior shoulder prominent dorsally, arising abruptly from shell surface at hinge line, flaring, gradually joining surface below. Medial node low (not as high as shoulder), marked by polygonal pits, which cover it without interrupting their regular pattern on shell surface. Pits around posterior end somewhat elongate, aligned parallel to posterior margin. Kirkbyan pit distinct, ovate in outline, located at anteroventral edge of medial node. Greatest height central. Inner carina thin but continuous around ventral margin from center of end margins, subparallel to outer carina which becomes more prominent and is parallel to free margins.

Instars M-2 to M—Thickness, M-2, 0.287 mm.; M-1, 0.350 mm.; M, 0.436 mm. The three largest instars are similar to M-3 except that there is an increase in the size of pits, inner and outer carinae, and the kirkbyan pit, while the relative prominence of the shoulder and medial node decrease further, lessening the depth of the trough between them. M-2 has all of the adult surface features and there is a gradual variation of these features as indicated above until in the M instar, the anterior shoulder and medial node exist only as slight swellings on the shell surface, although the anterior shoulder still has some prominence on the anterodorsal margin.

To summarize, the development of the medial and anterior nodes present most interesting variations in this species. Beginning with the youngest known specimen, the anterior node is the most conspicuous feature, but it gradually diminishes in prominence through successive instars, by assuming the character of a shoulder at the anterodorsal angle, and finally its ventral margin merges imperceptibly with the shell surface. The medial node is absent on the youngest shell, but is very prominent and spinose on the next instar. It continues to be the most noticeable surface feature throughout the next four instars, but after M-3 it becomes inconspicuous due to a gradual decrease of height and increase of diameter, until in the last instar the node is no more than a slight swelling in the shell surface.

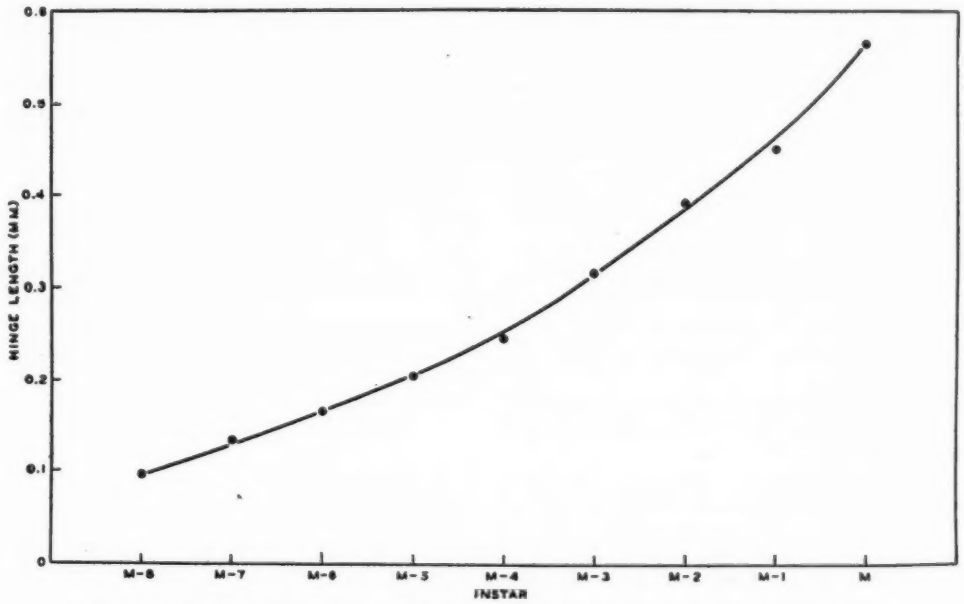


FIG. 3—Graph showing length of hinge of successive instars of *Ectodemites plummeri*.

This brings up speculation as to the ontogenetic function of these nodes. Most

workers have considered them to be the brood pouches for the accommodation of eggs or of young. However, in this species the greatest development of both anterior and medial nodes occur in instars that are three or more removed from the adult, so a function other than that connected with reproduction is indicated.

The length of the hinge does not vary directly with shell growth, but is proportionately greater in the larger instars resulting in a curve that is concave upward (fig. 3). The thickness also varies in the same manner, although the increase for later instars is at a slightly smaller rate than that for hinge length.

The carina bordering the free margins, absent in the first instar, begins as a short, faint line in the posteroventral region. The line becomes longer and more prominent in successive instars, reaching the cardinal extremities in M-5. It increases in size through to the adult stage. The inner carina, a feature of extreme variability in some Kirkbyidae, especially in some species of *Amphissites* and *Polytylites*, is only slightly developed in *E. plummeri*. The first faint beginnings of this carina are found on M-5, and it gradually develops into a thin irregular ridge subparallel to the outer carina. It reaches its maximum development in M-1 and on M is slightly reduced and somewhat irregular. At its greatest development it runs from the center of the anterior margin almost to the center of the opposite margin.

The kirkbyan pit, a feature common to all Kirkbyidae, makes its appearance surprisingly late in the development of the shell. Although it may be obscured by the surface pits in earlier moults, it is first recognizably distinct in M-4, after which it increases in size and depth to the end of the series.

The polygonal pits, completely wanting on the smallest instar, are relatively few in M-7. They are so numerous as to cover shell surface in M-6, but have no orderly arrangement. From M-5 on they gradually increase in size and angularity, those on the posterior becoming slightly elongate, and aligning themselves in rows parallel to the free margin. In the later instars the surface appears covered with a meshwork of polygonal pattern.

The lateral outline is distinctly asymmetrical in the earlier stages, the posterior height being somewhat greater than the anterior. However, this difference decreases with each successive moult and the larger instars are almost bilaterally symmetrical. Likewise the greatest thickness, disregarding the height of the medial nodes, is anterior in the young instars but becomes medial in the final instar.

Criticism is invited on the analysis of the moult history of fossil ostracodes herein presented. It is planned to extend this study to collections from older and younger stratigraphic zones, and already some material has been loaned for this purpose. Additional material will be welcomed.

As stated, the method of length-height graphs has been called upon and has been found useful in solving taxonomic problems in several species belonging to other genera. As a result the form ratio of ostracode shells assumes greater importance than heretofore recognized, and it is hoped that other workers will, from time to time, contribute further data on these relations.

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JOURNAL OF PALEONTOLOGY, VOL. 19, NO. 4, PP. 376–379, PL. 58, JULY 1945

CRYPTOZOONS OF THE SHAKOPEE DOLOMITE

CLINTON R. STAUFFER

ABSTRACT.—The *Cryptozoon*, a lime-secreting Alga, is common in the early Paleozoic rocks of North America where it often tends to form reefs. In the upper Mississippi Valley this genus is more or less abundant in the Shakopee dolomitic limestone. To the several known species of that formation another is added—*Cryptozoon rosemontensis*.

INTRODUCTION

IN MANY of the limestones, the dolomites and the cherts of various ages, at least as far back as the Proterozoic in North America, there appear hemispheric often flattened calcareous and siliceous masses consisting of nesting inverted bowl or thimble shaped layers and other somewhat irregular structures that suggest organic deposition. Such masses have been described (Walcott, 1912) from the ancient calcareous deposits of the Steep Rock Lake region, and similar ones occur abundantly in the Lake Superior district where they have been collected from the Biwabic formation of Minnesota (Grout and Broderick, 1919; Gruner, 1924). Great numbers of such masses occur in the Newland limestone (Belt series) and other limestones of similar age from the Belt Mountains (Walcott, 1916) to the Grand Canyon. Others have been described from the Green River formation (Bradley, 1928, pp. 203–223, pls. 32–46) and some are even found in the deposits now forming in Green Lake, New York (Bradley, 1928, pp. 204–206, pls. 29–30) in Ore Lake, Michigan (Pollock, J. B., 1918, p. 249), in the waters of Mammoth Hot Springs, Yellowstone National Park (Weed, W. H., 1889, pp. 619–676, pls. 78–87, figs. 52–56), and even on the modern sea bottom itself (Mayor, A. G., 60, 1921, p. 67). Some of these calcareous masses appear to be part of the skeletal structure of some definite organism while others are perhaps merely precipitated through organic agencies. In either case they become part of the record of life constituting the fossils familiar to the stratigrapher and the paleontologist. It matters little whether cell structures are preserved or not. If definite recognizable masses are formed they become part of the fossil content of the formation in which they occur.

THE CRYPTOZOONS

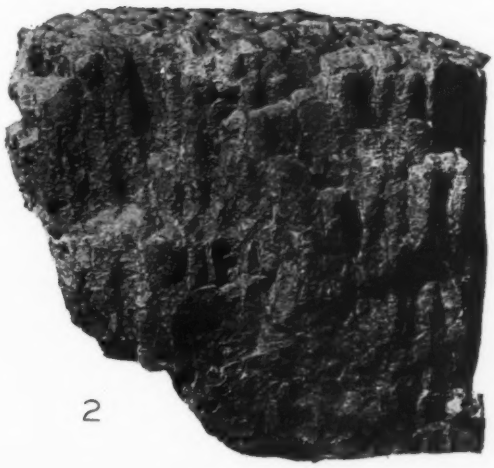
The great organically formed hemispherical masses, common in the Lower and Middle Paleozoic, were originally included in the *Stromatoporoidea* and thought to be ancient Hydrozoa. Probably this is the true classification of many of them but in 1883 James Hall discovered some fundamental differences which caused him to separate out certain of the more primitive ones found in the Beekmantown at Saratoga, New York. These he described as the new genus, Cryptozoon, which he referred to the algae. Since

EXPLANATION OF PLATE 58

FIGS. *1, 2, 4, 5—Cryptozoon rosemontensis* Stauffer, n. sp. *1*, A weathered surface showing sections of the nesting shallow saucer-like cups that make up the pillars, ×1/3. Specimen from Pine Bend, Minnesota. *2*, A vertical view of the same specimen showing the pillars and their bifuration to increase the number, ×1/3. *4*, A polished vertical section of the same specimen as above, ×1. *5*, Top view of the type specimen showing the upper ends of the pillar-like or finger-like stacks of saucer-shaped masses forming the colony, ×1/3. Specimens from the Shakopee dolomite at Pine Bend, Minnesota. (p. 379)

3, 6—Cryptozoon minnesotensis N. H. Winchell. *3*, A specimen similar to 6 split open to show concentric structure, ×1/3. Specimen from the Shakopee dolomite at Pine Bend, Minnesota. *6*, A mushroom-like mass "exploded" from the surface of a large hemispherical specimen. These wart-like protuberances may be new colonies formed by a bud-like process, ×1/3. From the Shakopee dolomite at Pine Bend, Minnesota. (p. 378)

1



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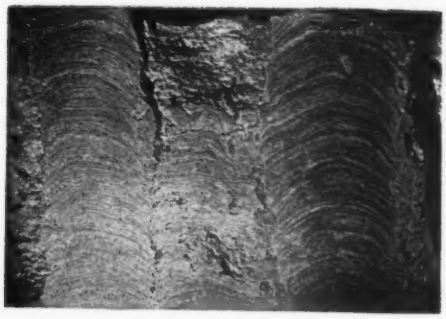

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Stauffer—Ordovician Cryptozoans

that time many such masses have been described and likewise placed among the primitive plants. Geologists usually recognize them at once and regard them as different from any other fossils known and likewise different from the spherical and discoidal concretions that apparently some workers would confuse with them. Geologists and stratigraphers have recognized the *Cryptozoons* to be calcareous algae but these have never been well received as such by many paleobotanists, particularly the English, who seem to think these masses have much to be overlooked or forgiven before they can be admitted to the realm of the algae. The lack of a cellular framework is cited as a reason why they should not be referred to that phylum. Without such structure it is considered difficult to distinguish between them and the somewhat similar masses of calcareous material commonly called *Stromatoporoids* on the one hand and the dendritic tufas and biscuit-like masses thought to owe their origin to precipitation of calcium carbonate through the agency of blue-green algae or even straight chemical precipitation on the other hand. To many, if not most, American workers they seem to have life characteristics of deposition rather than the pattern of inorganic chemical precipitation and their reef-like habits are considered to support that conclusion. Dr. Seward, however, says that "the general belief among American geologists and several European authors in the organic origin of Cryptozoons is, I venture to think, not justified by the facts," (Seward, A. C., 1931, p. 86) and he is followed by many other paleobotanists. Later in the same work Seward (1931, p. 89) says, regarding *Atikokania*, that "it may be included in the category of inorganic structures to which *Cryptozoon* belongs."

The Cryptozoons have somewhat the habit of growth of *Lithothamnion* although they are probably not very closely related. It is known that the deposits made by modern *Lithothamnion* reefs change rapidly, due to the destruction of the cells by percolating water, and the whole algal bank may soon become a compact structureless limestone (Walther, J., 1885, p. 329). Doubtless this is the fate often visited upon the *Cryptozoon* of the early Paleozoic and the dolomitization of limestone may have altered the structure of those individuals that maintain their shape until the possibility of a satisfactory study of the cell structure, even if it ever existed, is so reduced that definite observation is now quite impossible.

Commenting on James Hall's description of the species *C. proliferum* from the limestone at Saratoga, New York (Cushing, H. P., and Ruedemann, R., 1914, pl. 3), N. H. Winchell stated that he and his staff had collected Cryptozoons from the Shakopee dolomite over a period of ten years and that some specimens had been referred erroneously to the Stromatoporellas (Winchell, N. H., 1886, p. 313).

In certain regions it appears that the calcareous and dolomitic beds of the Shakopee dolomitic limestone may have been formed largely of Cryptozoons and that algae or algal sands played an important part in its deposition. Portions of the formation are characteristically oolitic and in some regions such beds tend to become silicified. Many of the flint nodules are oolitic and often carry fossils.

The shaly beds, the local sandy lenses, and the diastems indicate that the Shakopee had a varied history during the period of its deposition. The evidences of subsequent solution and compaction, the dolomitization and the varied thickness of certain of its members suggest that much may have happened to it since sedimentation was completed. All these changes have tended to destroy its fossils and this has been as true of the algal as of the animal remains. In fact, it is probable that the algae would be more susceptible to such destructive agencies than other types of organic remains.

Some of the finest specimens of Cryptozoons came from Cannon Falls but they are common at numerous other localities where this formation crops out. Several different species have been found in the Shakopee of Minnesota and described in the geological literature of the state, but the finding of a new species and an abundance of material of those that are known makes it seem worthwhile to describe the new and review the old species.

DESCRIPTION OF SPECIES

The several species of *Cryptozoon* that occur in the Shakopee may all be found as parts of the same reef. Although a single species may be responsible for a reef it rarely occurs as an isolated colony.

CRYPTOZOON MINNESOTENSIS
N. H. Winchell
Plate 58, figures 3, 6

Cryptozoon minnesotensis Winchell, 1886, Minnesota Geol. and Nat. History Survey, 14th Ann. Rept., pp. 313–315, pl. 1, figs. 1 and 2, and pl. 2, fig. 3.

The specimens of this species are great hemispherical masses, slightly flattened and showing very fine concentric laminations. The layers or laminae conform to the convex surface and over it are blister-like elevations that do not develop regularly and are prominent only on the weathered surface. Certain of the laminae tend to peel off, but this may be a weathering phenomenon. It is probable that these algae were affected by various boring forms, some of which may have been worms, but such features should not figure in the descriptions of the *Cryptozoon* species. Winchell asserts that the laminae are "as frequent as six or eight . . . in a quarter of an inch, as visible to the naked eye. In a thin section the fine lines indicating the sections of the laminae are as numerous as ten to fourteen in a quarter of an inch." The largest perfect specimen that was found detached, is that collected by Mr. Scofield at Cannon Falls where it had weathered out of the Shakopee dolomite. This specimen is now in the Geological Museum at the University of Minnesota. It is nearly sixteen inches in diameter across the base and eight inches in height. The various specimens collected and observed in the field show the flattened under surface to be concentrically ridged or furrowed and always to give the inverted bowl-like appearance. The Shakopee at Cannon Falls contains great numbers of this species which vary greatly in size, some being as small as three inches in diameter. In some portions of the formation they overlap each other and assume various shapes when crowded into the reefs.

Winchell remarks that

> these forms may be varieties of Professor Hall's species *C. proliferum;* but they differ markedly from that in the manner of growth. They are convex upward, instead of concave, and while having apparently a main central point of attachment from which growth proceeded, they spread laterally over the surface, and each grand added layer of growth seems to be expressed in the concentric undulations seen on the base, which has a central depression rising toward the center of the mass.

This suggested orientation of Hall's specimens seems to be incorrect and the manner of growth of *C. proliferum* is probably the same as in *C. minnesotensis*. An excellent surface of the *Cryptozoon proliferum* reef at Saratoga is now exposed (Cushing, and Ruedemann, 1914, pls. 3 and 4). This surface was planed down by glaciation so that one sees a mid-horizontal section of the algal masses that seems to suggest a downward or basin shape to the concentric laminae. Some of the specimens in the Shakopee seem to explode upward into puffball form or mushroom shaped masses where they are crowded into reefs. The general pattern of growth, however, is that as sketched and many specimens are much larger than the type specimen described by Winchell.

Horizon and locality.—From the Shakopee dolomitic limestone at Cannon Falls, Hastings, Shakopee, Mankato, etc.

CRYPTOZOON LIBERTATIS, N. H. Winchell

Cryptozoon libertatis Winchell, 1886, Minnesota Geol. and Nat. History Survey, 14th Ann. Rept., pp. 314–315, pl. 2, fig. 4.

This species was originally described as a variety of *C. minnesotensis* but it differs greatly from that species as found abundantly in Minnesota and apparently in adjacent regions.

> The specimens . . . are subcylindrical with a conical upward apex. They are from one to three inches long, the length depending apparently on the circumstances that attended their removal from the enclosing rock, and from one to two inches in diameter. They appear, outwardly, like a succession of cups, or thimbles, piled on each other, the lower end of each covering the upper, closed end of the one below it. But the lower edge of each cup is ragged, and capriciously fractured, due to the weathering out of the specimen from the enclosing rock, for it is probable that the specimens would not be discovered except for the distinctness of the cup-shaped lamination which is made conspicuous by exposure to the weather. It is evident that they are not always cylindrical or subcylindrical, since the impressions of the

apices of several, remaining on the under surface of a small slab of rock, are somewhat elongated, though the most of these are concave, and shaped like the conical tops of the most of the detached specimens. The frayed edges of the laminae vary in frequency and in thickness. Generally two to three occupy the space of a quarter of an inch, but the intimate structure shows, in a thin section, a much finer lamination, viz., from six to ten laminae in a quarter of an inch.

Winchell's specimens came from Northfield but the species may be found at various other places throughout the occurrence of the formation. This species often forms distinct layers or beds that may be traced along the face of a cliff or quarry for many feet. The specimen came from a road cut in the hills west of Lake City, Minnesota, where such a layer is well developed:

Horizon and locality.—From the Shakopee dolomitic limestone at Northfield, Lake City, Zumbro Falls, etc., in Minnesota.

Cryptozoon rosemontensis Stauffer, n. sp.

Plate 58, figures 1, 2, 4, 5

Large, somewhat flattened, hemispherical masses 45 cm. to 60 cm. in diameter, consisting of successive thin layers or shell-like laminae that arch up over the hemispherical mass. While these appear to be continuous, frequent upward bulges or thickening of the laminae produce long finger-like polygonal pillars like stacks of small inverted nesting saucers or watch glasses which have an average diameter of about 15 mm. These laminae are in double series, the coarser or major ones are about 1 mm. thick in the top of the arch but each seems to be made up of very much finer or thinner laminae of which there are 6 to 8 to each of the larger.

As the crown of the specimen, or the whole colony, expands, these pillars increase in cross-section then bifurcate, thus adding to the total number but keeping the average about uniform in size. While the lamination is continuous it is very thin between pillars or at the margins of the saucer-shaped segments. On slight weathering these thinner marginal portions appear to break down and the pillars may easily be separated from those adjacent. A polished surface shows no definite cell frame-work but partial dolomitization may have destroyed such if once present.

Horizon and locality.—From the Shakopee dolomitic limestone at Pine Bend, Dakota County, Minnesota. This is on the property of the Rosemont plant of the Gopher Ordnance Co., near the lower wells, adjacent to the Mississippi River.

Manuscript received June 6, 1944.

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JOURNAL OF PALEONTOLOGY, VOL. 19, NO. 4, PP. 380–382, 1 TEXT FIG., JULY 1945

TWO NEW OSTRACODA FROM SUBSURFACE COOK MOUNTAIN (EOCENE) STRATA OF TEXAS[1]

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CONSIDERABLE portions of the Claiborne Eocene strata outcropping in Texas are nonmarine to brackish in origin. In the subsurface, the up-dip portions of these beds are often only sparsely fossiliferous. Foraminifera in these strata are at times very rare or absent, and Ostracoda assume greater importance than would be the case in material carrying a more diversified fauna.

The two species of *Haplocytheridea* here described were taken from subsurface beds of the Cook Mountain formation, Claiborne Eocene of Texas. These forms were originally pointed out to the author by J. B. Garrett, and have been observed over considerable areas in subsurface Cook Mountain strata. They have not been noted by the writer in surface exposures of the same age.

The specimens upon which the new species are based were obtained from Magnolia Petroleum Company's no. 1 Mary Teal well, located about 2¼ miles north of Byrne, McMullen County, Texas. The writer is indebted to Philip H. Jennings and Stuart Mossom, of Magnolia Petroleum Company, who kindly granted permission to publish on this material. Type specimens will be deposited in the Louisiana State University Museum, Baton Rouge, Louisiana.

SYSTEMATIC DESCRIPTIONS

Family CYTHERIDAE Baird, 1850

Genus HAPLOCYTHERIDEA Stephenson, 1936

HAPLOCYTHERIDEA IOTA Stephenson, n. sp.
Figures 3–5

Carapace rather small, tumid; in side view short, subpyriform. Anterior end broadly, evenly rounded, often weakly denticulate; posterior end narrower, bluntly truncated to posteroventral angle, which carries traces of spines on some specimens. Dorsal margin well arched, flattened along hinge line in right valve. Ventral margin fairly straight, in left valve with a lobe of the shell wall produced ventrally below it. Tumid portion of carapace ornamented with numerous shallow, vertical, curvilinear furrows containing pits of moderate size. Furrows on anterior half tend to be arcuate toward anterior, those on posterior convex posteriorly. Hinge structure of right valve consists of elongate, terminal, taxodont dental areas, each notched to form six to eight cusps. A row of lower, fine crenulations visible between dentitions. In left valve, hinge formed by well depressed, notched sockets, joined by finely crenulate groove. Slender bar present above groove, separated from dorsal margin by well-depressed area. Marginal areas of moderate width, carrying numerous simple, irregularly disposed radial pore canals. Line of concrescence coincides with inner margin except on anterior and posterior ends, where it extends into marginal area. Muscle scar pattern typical for genus, consisting of vertical row of four small scars, with two more situated anterior to them.

Length (complete specimen) 0.63 mm.; height 0.41 mm.; width 0.31 mm. Length (right valve) 0.61 mm.; height 0.37 mm. Length (left valve) 0.63 mm.; height 0.42 mm.

Remarks.—The short, blunt outline in side view, together with the ventrally produced inflation of the left valve, are criteria which rather readily distinguish this species. *Haplocytheridea veatchi* (Howe and Garrett) (1934, p. 43, pl. 3, figs. 1–4), a species present in Wilcox and Claiborne Eocene sediments, is lower and much more elongate, and lacks the ventral inflation.

Types.—Holotype, no. 3300, from core at 1913–1922 feet; paratypes, nos. 3301, 3302, from core at 1876–1882 feet.

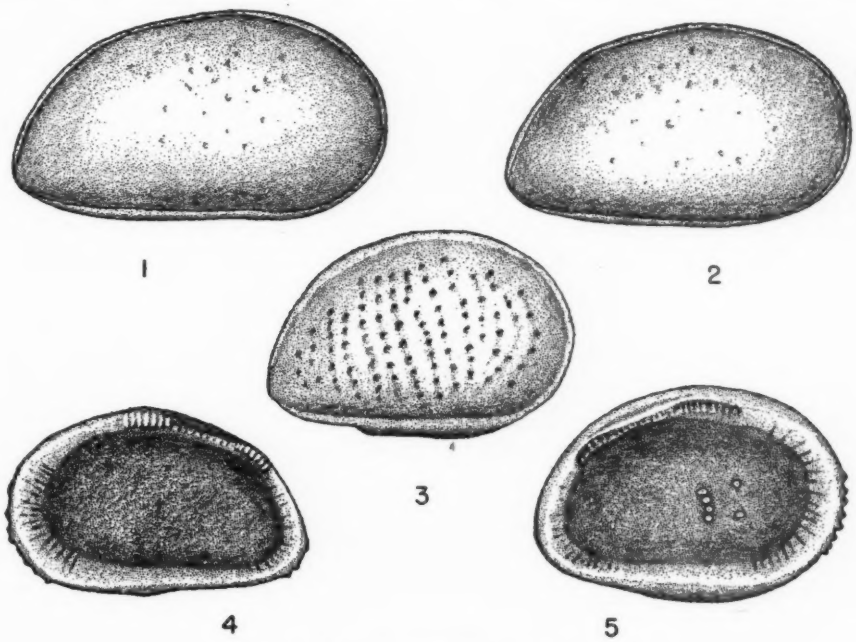
[1] Published with the permission of the Stanolind Oil and Gas Company.

HAPLOCYTHERIDEA MOSSOMI
Stephenson, n. sp.
Figures 1, 2

Carapace elongate, in side view subpyriform. Anterior end broadly, evenly rounded, may be weakly spinose; posterior end narrower, sloping to roundly pointed posteroventral angle. Dorsal margin weakly arched between obscure cardinal angles; ventral margin straight to slightly convex. Surface smooth, with scattered small, faintly impressed pits marking positions of normal pore canals. Hinge structure rather weak, in right valve with slender, elongate, weakly notched dental areas, separated by narrow, faintly crenulate bar. Hinge in left valve bears elongate, notched sockets, joined by narrow, finely crenulate groove. Inconspicuous bar above groove separated from dorsal margin by shallow depressed area. Marginal areas of moderate width, carrying about 30 straight, simple radial pore canals on anterior, fewer on posterior. Line of concrescence coincides with inner margin except on anterior and posterior, where it extends somewhat into marginal area. Muscle scar pattern typical for genus.

Length (male) 0.77 mm.; height 0.42 mm.; width 0.32 mm. Length (female) 0.72 mm.; height 0.41 mm.; width 0.33 mm. Length (right valve) 0.71 mm.; height 0.37 mm. Length (left valve) 0.73 mm.; height 0.41 mm.

Remarks.—*H. mossomi* is rather distinctive in its lack of surface ornamentation. This feature distinguishes it from *H. moodyi* (Howe and Garrett) (1934, p. 35, pl. 2, figs. 2–6), which is similar in shape but well ornamented. A closely allied species is to be seen in *H. mexicana* Stephenson (1942, p. 109, pl. 18, fig. 13), from the Eocene on



EXPLANATION OF FIGURES 1–5
All figures ×65

FIGS. *1, 2—Haplocytheridea mossomi* Stephenson, n. sp. *1,* Right valve view of male, holotype no. 3303. *2,* Right valve view of female, paratype no. 3304.
3–5—Haplocytheridea iota Stephenson, n. sp. *3,* Right valve view of entire carapace, holotype no. 3300. *4,* Interior of right valve, paratype no. 3301. *5,* Interior of left valve, paratype no. 3302.

Moctezuma River, State of Vera Cruz, Mexico. The new species lacks the shallow, closely spaced pitting which is characteristic of the form from Mexico.

Types.—Holotype (male), no. 3303; paratype (female), no. 3304; paratype (right valve), no. 3305; paratype (left valve), no. 3306. All specimens from core at 1913–1922 feet.

MANUSCRIPT RECEIVED DECEMBER 12, 1944.

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JOURNAL OF PALEONTOLOGY, VOL. 19, NO. 4, PP. 383–389, 8 TEXT FIGS., JULY 1945

KINKAID CORALS FROM ILLINOIS[1]

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ABSTRACT—Three species of corals from southern Illinois are discussed. Two are good guide fossils and aid in correlating the Kinkaid limestone of Illinois and the Pitkin limestone of Arkansas. One new genus and one new species are described.

INTRODUCTION

CORALS are abundant locally in the Kinkaid limestone of southern Illinois but only one place is known where species other than the ever-present *Triplophillites* may be collected (Lamar, 1925, p. 80). A section measured there (a gully about 100 yards west of the road, 0.4 mile north of Cedar Grove Church, in the NE¼, NW¼, sec. 31, T. 11 S., R. 2 E., Johnson County, Illinois) is as follows:

	Thickness Ft.	Thickness in.
Pennsylvanian		
Caseyville group (Wayside formation)		
17–19. Sandstone and platy shale		
Mississippian or Pennsylvanian		
14–16. Shale, gray, partly sandy or plastic, poorly exposed	6	9
Mississippian		
Elvira group		
Kinkaid limestone		
13. Limestone and shale. Argillaceous, fossiliferous limestone which weathers brown, interbedded with gray and buff shale. Carries abundant *Triplophyllites* and *Kinkaidia* in the limestone	3	6
12. Shale, dark gray, and blue-gray shale, probably with some thin limestone lenses. Partly covered	5	10
11. Limestone, gray, locally granular or nodular, in 9- to 18-inch beds. Highly fossiliferous; crinoid stems, large *Archimedipora*, and horned and colonial corals especially common. No brachiopods observed. Carries abundant *Caninostrotion* in lower part.	16	—
10. Shale, dark gray and blue-gray, plastic, with dark gray, granular limestone nodules	2	7
9. Limestone, gray, locally granular, fossiliferous	18	4
8. Shale, dark gray, partly concealed	1	10
7. Limestone, thin-bedded, slabby, gray. Profusion of *Myalina* sp. Also numerous brachiopods	1	7
6. Shale, greenish gray, soft. Partly concealed	4	1
5. Shale, nodular, hematite-red color	4	3
4. Shale, green-gray clay shale, the lower part of which contains angular nodules of dense, gray semilithographic limestone, and grades downward into the bed below	4	—
3. Limestone, nodular, dense, gray. Lower portion contains layers of shale and dark gray siliceous limestone	10	—
2. Shale, with nodules of dense gray limestone. Partly concealed	10	6
1. Limestone, siliceous, dark gray, with irregular cherty banding	2	—
	98	—

The coral species occurring in beds 11 and 13 also are present in the upper part of the Pitkin formation of western Arkansas (collections from the base of the Pitkin in western Arkansas actually are from the upper part of the formation as a whole). Other corals occurring in the Pitkin have not been observed in the Kinkaid. Nevertheless, two of the species common to both formations are so unusual as to suggest close correlation of the zones in which they occur. Corals

[1] Published by permission of the Chief, Illinois State Geological Survey, Urbana.

are considered very sensitive to environmental changes, hence, it appears that migrational routes must have existed between the Kinkaid sea of Illinois and the Pitkin sea of Arkansas. *Caninostrotion* is abundant in the upper part of the Pitkin and common in only one observed bed of the Kinkaid, but on the other hand *Kinkaidia* is abundant in one bed near the top of the Kinkaid and has only been reported once from the (upper part of the) Pitkin. Considerably more work must be done on these faunas, especially on that of the Kinkaid, before definitive conclusions can be reached regarding connection of the seas. Even so, a partial emendation of the writer's previous views is in order.

The writer has stated (Easton, 1943, pp. 128–129) that "faunal migration from Europe or Asia apparently reached this ocean [lying south of North America] and certain corals of unique aspect migrated northward with the Pitkin sea but were unable to cross into the Illinois Basin," and that "there appears to be no evidence that the two basins were directly joined in Pitkin time." The extension of knowledge presented in this paper concerning the geographic distribution of the corals shows that the two basins probably were connected and that favorable ecologic conditions of unknown duration enabled faunal migration of some distinctive organisms. Not all of the Pitkin corals are yet known to have lived in the Illinois region during Kinkaid time and many other distinctive faunal elements either remain undiscovered in strata of the adjacent seas or actually did not cross a possible ecologic barrier between the seas.

ACKNOWLEDGMENTS

Collections were made with the assistance of Mr. C. L. Cooper and Mrs. Phoebe Beall Easton. Mr. G. A. Cooper lent Pitkin material for study and Mr. J. E. Lamar contributed information concerning his work at the Kinkaid locality.

SYSTEMATIC DESCRIPTIONS

The morphologic terminology used in this paper has been outlined previously by the writer (Easton, 1944).

Phylum Coelenterata
Class Anthozoa
Order Tetracoralla
Family Metriophyllidae
Genus Kinkaidia Easton, n. gen.

Diagnosis.—Simple, curved to cylindrical, rugose corals; counter septum long, may be rhopaloid; pair of counter-lateral septa bordering counter septum rather long, may be rhopaloid; cardinal septum short except in young stages; alar septa long, may touch counter septum even in mature stage; other major septa of equal strength, withdrawn from axis in mature stage, commonly rhopaloid; minor septa rudimentary; tabulae distally arched, both complete and incomplete types present; tabellae sparse, broadly arched; dissepiments absent.

Genotype.—*Kinkaidia trigonalis*, n. sp.

Remarks.—This genus differs from *Claviphyllum* Hudson, 1942, in having long alar septa in late stages, a relatively long counter-lateral septum on each side of the counter septum, and tent-like rather than globose tabellae. The two genera are very closely related, *Kinkaidia* being a potential ancestor of *Claviphyllum;* the former could give rise to the latter by reduction in length of the alar septa, by insertion of short septa between the counter septum and the counter-lateral septa, and by increase in complexity of the tabellae.

Sochkineophyllum Grabau, 1928, is also related to *Kinkaidia*, differing from it in the absence of long alar septa and the long counter-lateral septum on either side of the counter septum, and in having several pairs of long rhopaloid (axially swollen) major septa.

Malonophyllum Okulitch and Albritton, 1935, though possessing the same general characters as the foregoing genera, lacks tabulae.

Lophophyllidium Grabau, 1928, may have been derived from *Kinkaidia* by reduction in length of the alar septa and by loss of the rhopaloid character of the major septa in late stages. The two genera resemble each other in the relative lengths of major septa (other than alars), in the nature of the tabulae, in the absence of dissepiments, and in the inconsistent development of minor septa. The stratigraphic occurrence of these

two genera suggests that *Kinkaidia* might be the possible ancestor of *Lophophyllidium*. *Claviphyllum*, on the other hand, was contemporaneous with *Kinkaidia*.

KINKAIDIA TRIGONALIS Easton, n. sp.
Figures 1–7

Externals.—Medium size, almost geniculate; calyx very deep; epitheca thick, bearing prominent interseptal ridges, septal grooves, encircling striae and rugae; cardinal fossula probably pronounced; alar pseudofossula indicated.

Transverse sections.—In early ephebic stage (diameters 4.1 by 6.0 mm.) counter septum very long, almost in contact with relatively long cardinal septum; alar septa long but not reaching axis; counter-lateral septum on either side of counter septum slightly longer than other metasepta; four septa in each counter quadrant, three in each cardinal quadrant; septa noticeably swollen axially; tabular intersections sparse.

In middle ephebic stage (diameters 7.6 by 7.7 mm.) counter septum and both alar septa about equal in length, meeting axially; cardinal septum very short, flanked on one side by three and on other by four metasepta which tend to lean toward cardinal septum; counter-lateral septum on either side of counter septum extend half of radius; counter quadrant contains five, the other, six septa; most septa axially swollen; tabular intersections common; minor septa suggested by only slight swellings of epitheca between majors.

At very slightly later stage another specimen has 25 major septa; counter septum long, much swollen axially; each neighboring counter-lateral septum long, one alar short; neither alar septa nor cardinal septum distinguishable; rudimentary minor septa present in most loculi.

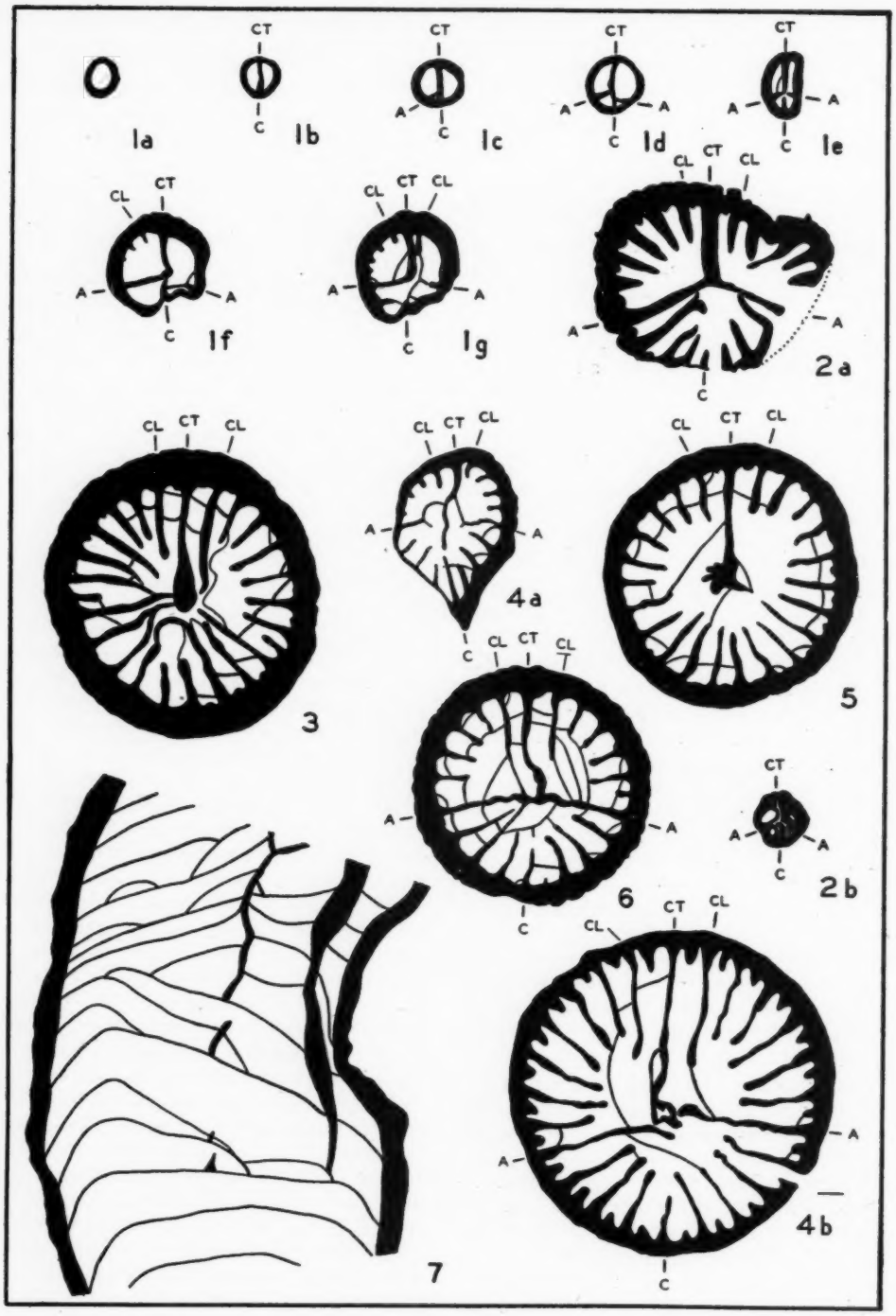
In very late ephebic stage (diameters 10.7 by 10.7 mm.), 24 major septa, alternating with equal number of short minor septa; counter septum very long; alar septa long, not quite reaching counter septum; counter-lateral septum on either side of counter septum extends two-thirds of radius; cardinal septum short; four metasepta in one cardinal quadrant and three in other lean toward cardinal septum; counter quadrants contain six and seven septa; most majors rhopaloid.

Longitudinal section.—Tabulae both complete and incomplete, with rather sharply down-turned borders, slightly convex distally; tabellae broadly arched toward intersection of counter septum.

Remarks.—This species has been listed by the writer as "cup coral unidentified" (Easton, 1943, p. 130) from the Pitkin formation.

Ontogeny.—In earliest brophic stage (fig. 1a) only the epitheca is present, there being no septa or tabulae. The cardinal septum and the counter septum are inserted first to form an axial plate (fig. 1b). The right alar then appears (fig. 1c), followed by the left alar. At this stage, the top of the right alar has shifted somewhat axially (fig. 1d). Later the four primary septa become thickened, the alars move to positions nearly at right angles to the cardinal-counter plane and one alar septum is separated from axial contact with the other septa, the cardinal and counter septa separate slightly, and a tabula appears (fig. 1e). Metasepta, traceable as septal grooves on the epitheca, are inserted in the counter quadrants but are not always discernible in the thecarium (fig. 1f). By early neanic stage (fig. 1g) metasepta occur within the thecarium in the cardinal quadrants and tabulae are common; one counter-lateral septum is noticeably longer than the neighboring septa and is axially swollen.

In early ephebic stage (fig. 4) there are 4 slightly rhopaloid septa in the counter quadrants and 3 in the cardinal quadrants; the counter septum is long and the cardinal septum is short; the counter-lateral septa are slightly longer than the neighboring septa. The typical features are observed in middle ephebic stage (fig. 6) where the counter septum and the alar septa meet axially, the cardinal septum is short, the counter-laterals are long; 5 or 6 septa occur in the counter quadrants and 3 or 4 are present in the cardinal quadrants, most of them being axially swollen; tabulae are common and may bear traces of septal extensions as spines. A section through a calyx at this stage gives indications of a pronounced cardinal fossula and observable alar pseudofossula (fig. 2a). In late ephebic stage (fig. 3)



FIGURES 1–7

the counter septum is markedly rhopaloid and rudimentary minor septa appear. Axial fusion tends to be dissipated in very late ephebic stage (fig. 4b), the majors are sinuous and axilly swollen, and minor septa are pronounced.

Occurrence.—Specimens were collected by the writer from bed 13 of the measured section at the Illinois locality. One specimen, collected by G. A. Cooper from the base of the (upper part of the) Pitkin formation, 3 miles east of Elkins, Arkansas, was lent for study.

Material.—The following specimens are in the collections of the Illinois State Geological Survey: holotype no. 3512; figured paratypes no. 3513; unfigured paratypes no. 3514. Figured plesiotype: U. S. National Museum.

Family HAPSIPHYLLIDAE Grabau emend. Easton, 1944

Genus TRIPLOPHYLLITES Easton, 1944

Remarks.—*Triplophyllites* was proposed for specimens generally identified as "*Triplophyllum*" in the United States. For a complete diagnosis of the genus and a discussion of its relationships, see Easton 1944, pp. 35–42.

TRIPLOPHYLLITES PALMATUS Easton

Triplophyllites palmatus Easton, 1944, Illinois Geol. Survey, Rept. Inv. 97, p. 35, pl. 8, figs. 1–6.

Remarks.—This species has been differentiated on the following characters (Easton, 1944, p. 36).

"*T. palmatus* differs from *T. spinulosusa* (Grove) in having the cardinal septum shortened by early ephebic stage; by its pronouncedly palmate grouping of septa in the counter quadrants, its very strong counter septum, and by the early reduction in the length of the cardinal septum. The generally trochoid shape, the very deep calyx, the strong interseptal ridges, and the sparse spines furnish external identifying characters."

This species has been figured recently in detail (Easton, 1944, pl. 8).

Family CANINIIDAE

Genus CANINOSTROTION Easton, 1943

Diagnosis.—(Easton, 1943, p. 134)

Compound rugose corals multiplying asexually chiefly by "peripheral increase" but possibly also by basal division. Cardinal fossula conspicuous in all but early stages, formed by down-bending of tabulae and shortening of cardinal septum. Dissepimentarium broad; dissepiments tend toward anguloconcentric pattern. Pseudocolumella intermittently developed, variable, formed by junction of axial ends of some major septa combined with distal arching of tabulae. Tabulae strong, irregularly arranged. Typically, septa are equally thickened in all quadrants.

CANINOSTROTION VARIABILIS Easton

Figures 8a, 8b

Caninostrotion variabilis Easton, 1943, Jour. Paleontology, vol. 17, no. 2, p. 134, pl. 21, figs. 14–16.

Externals.—Conical proximally, cylindrical distally; calyx deep, with septal traces on floor, steep-walled near floor, oblique near periphery; epitheca thin.

Transverse section.—In late ephebic stage (diameters 21 by 23 mm.) dissepimentarium extends half of radius, consists of irregular anguloconcentric, concentric and herring-

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EXPLANATION OF FIGURES 1–7

Kinkaidia trigonolis, n. gen. and n. sp.; ×5; (p. 385)

1a–1g—Successive, reversed, serial transverse sections from aseptate earliest brephic stage through early neanic stage.

2a—Transverse section in open calyx; *2b*, reversed transverse section near close of brephic stage.

3—Reversed transverse section in late ephebic stage with rudimentary minor septa.

4a—Reversed transverse in early ephebic stage; *4b*, transverse section in very late ephebic stage showing short secondaries and very long counter-laterals.

5—Transverse section in late ephebic stage; U. S. National Museum specimen from Pitkin formation.

6—Reversed transverse section in middle ephebic stage; holotype; Illinois Geological Survey No. 3512.

7—Longitudinal section.

All figures except 5 and 6 are of plesiotypes; Illinois Geological Survey No. 3513.

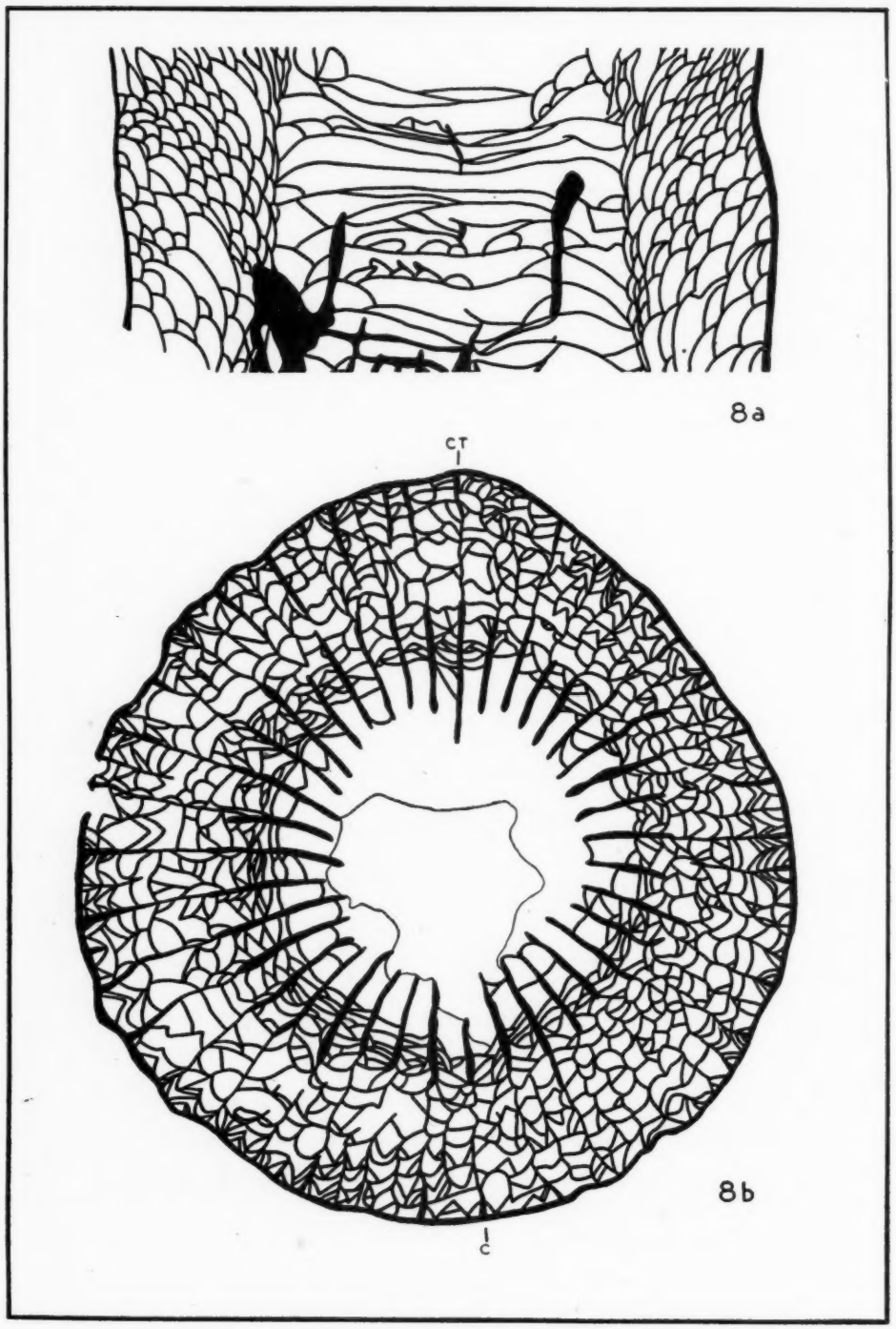

FIG. 8.—*Caninostrotion variabilis* Easton; plesiotypes; ×5. *8a*, Longitudinal section; *8b*, transverse section; Illinois Geological Survey No. 3517 (p. 387).

bone patterns with chevron-like dissepiments bordering major septa near epitheca; major septa extend three-fourths of radius, dilated within tabularium, weak to partially obsolete within dissepimentarium; cardinal septum short, flanked by somewhat pinnately arranged major septa; counter septum long; minor septa obscure to obsolete.

Longitudinal section.—Dissepiments of unequal size, slightly elongate; tabulae complete and incomplete, with moderately down-turned peripheries and axial portions slightly arched distally; tabular density about 22 per cm.; pseudocolumella intermittently present.

Remarks.—Although smaller than the original specimens from the Pitkin formation, these Illinois corals have no other differentiating characteristics and are therefore considered conspecific with *C. variabilis.*

MANUSCRIPT RECEIVED APRIL 6, 1944.

The species has been previously listed as "Cup coral n. gen. et. n. sp." (Easton, 1942, p. 84) from the Pitkin formation.

Occurrence.—Common near base of bed 11 of the measured section at the Illinois locality.

Material.—Figured plesiotypes: Illinois State Geological Survey No. 3517; unfigured plesiotypes: No. 3518.

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JOURNAL OF PALEONTOLOGY, VOL. 19, NO. 4, PP. 390–395, PL. 59, 9 TEXT FIGS., JULY 1945

PROCEDURE OF SIMPLIFIED STEREOPHOTOGRAPHY OF FOSSILS[1]

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USES OF THE PROCEDURE

STEREOGRAPHIC photography is of especial use where it is necessary to gain an impression of location in space and of configuration. Since the study of fossils involves frequent reference to the form of specimens as recorded in publications, stereoscopic photography may be made to serve the paleontologist by showing the configurations of the fossils in three dimensions.

The purpose of this paper is to describe a scheme for simplifying the making of stereoscopic photographs of fossils for files of fossil records and for publication. This plan is adapted for use by the average photographic worker.

The main purpose is to give the paleontologist a method of preparing for stereoscopic viewing two matched photographs of his specimens. The two views consist of one taken as is usual for publication and another taken from a slight angle to give the stereoscopic effect. The camera is so designed as to give a series of specific magnifications ($\frac{1}{2}$, 1, $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3, $3\frac{1}{2}$), which is the usual range of magnification for small fossils. The particular camera described uses a $3\frac{1}{4}'' \times 4\frac{1}{4}''$ film which determines the size of specimens that may be photographed at any given magnification. It is so constructed as to simplify the taking of these photographs and provides for a greatly simplified method of aligning and mounting.

There are several variations of the process that make it flexible to fit into different plans of use. The requirements that the process meets are in general these:

1. The apparatus is simple in construction and operation.

2. The procedure is so arranged as to require as few judgments of the operator as possible and to give perfect stereoscopic perception when operated by inexperienced persons.

3. The procedure gives one print (a) which is identical with those now usually taken for publication, and another print (b) which is taken from an angle and is used together with the first when the stereoscopic effect is desired. The degree of magnification of each print is to be that usually used for single views of small fossils (one to three and a half diameters). This is done in order that print (a) of the stereo pair will fit in with prints already in the paleontologist's files, which insures continuity of files. Print (a) can be used like ordinary fossil photographs if a nonstereo cut is to be made for publication together with some of the photographs already in the files. This print would also be of use in making comparisons with single views in other publications.

4. The mounting of the prints is facilitated by the use of simple "jigs" to give the proper trimming and location of the print.

CAMERA LENGTH CALCULATIONS

In order to construct a camera to give the required degrees of magnification, we calculate the image distance, using the basic lens equation:

$$\frac{1}{i}+\frac{1}{o}=\frac{1}{f}$$

where: i = image distance
o = object distance
f = principal focal length (as marked on lens)

The magnification is the image size divided by the object size. That it is also equal to image distance divided by object distance is shown by the drawing of undeviated rays forming two parts of an image (fig. 1).

Therefore, image distance equals magnification times object distance:

[1] This work, sponsored by Professor J. M. Kuehne, was done as an undergraduate (senior) research project at The University of Texas in 1943.

$$i=mo$$

or

$$o=\frac{i}{m}.$$

Substituting for o in the original lens equation:

$$\frac{1}{i}+\frac{1}{i/m}=\frac{1}{f}$$

$$\frac{1}{i}+\frac{m}{i}=\frac{1}{f}$$

and

$$i=(m+1)f$$

or total camera extension is equal to the

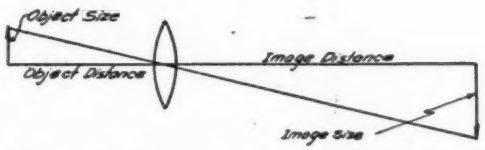


FIG. 1.—Relationship of object distance and image distance to magnification of photograph.

focal length plus the magnification times the focal length:

$$i=f+mf.$$

Since to increase the image distance by one focal length is to increase the magnification by one power, and since this ratio of increase holds for fractional powers, the assembly can be given a greater rigidity by substituting for bellows a series of wooden box-like segments of the proper length. That is, to add one power to the magnification, add one focal length to the bellows, and similarly for fractional powers.

A series of boxes including one segment of length $\frac{1}{2}f$ and three segments of length f will give all the magnifications in the series mentioned above when placed in an arrangement where the sum of the lengths of the two end segments (a and b, Fig. 2) is one focal length.

Construct the camera so that $a+b=f$

image distance $=(a+b)+$length of segments

$$i=f+mf.$$

To make such a camera, it is necessary to build it for the particular lens that is to be used. The principal focal length is taken as the value marked on the lens mount.

The lens used does not have to be of the finest but should have at least the correction of a rapid rectilinear. It is best to have a lens of about six-inch principal focal length with a diaphragm to close at least to f:32. The focal length should be great enough to

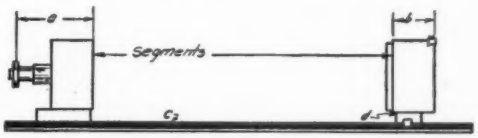


FIG. 2.—Diagrammatic sketch of camera.

avoid distortion by coming too close to the specimen; but too long a focal length lens will result in an ungainly camera.

CONSTRUCTION

The camera is made of two end pieces between which the additional segments are placed. The segments and the end pieces are box-like and are fitted end to end by light-tight joints. The two end pieces are the movable plateholder back (b) and the stationary lensboard (a). The plateholder back is movable along the camera base, but is held firmly against the base (c) by a clamping device made from a piece of $\frac{1}{16}$-inch spring brass.

The lensboard is a box-like segment open only at the end toward the back (fig. 2). The lens itself is in a brass tube that slides back and forth in another brass tube which is plush-lined and driven into a close-fitting hole in the lensboard. This adjustment of lens tube is used to locate the optical center of the lens so that $a+b$, in figure 2, is equal to one principal focal length. To make this adjustment, the first and last segments are joined and the camera is focused on a distant object. The lens tube is then clamped permanently in that position. (This movable lens tube also permits focusing if another lens is used to give magnification outside the range for which the camera was designed.)

The movable back is made as is shown in figures 2 and 3. It is made to hold a $3\frac{1}{4}''\times4\frac{1}{4}''$ pack adapter, or Speed Graphic holder, and

consists simply of a close-fitting rim which keeps the holder in place by friction. It is grooved so that the projection on the bottom of the plateholder will fit to make a light-tight joint. This arrangement has proved to be quite satisfactory because the holder is easily inserted without moving the camera. A ground glass mounted in a wooden frame is inserted in the place of the film holder for focusing.

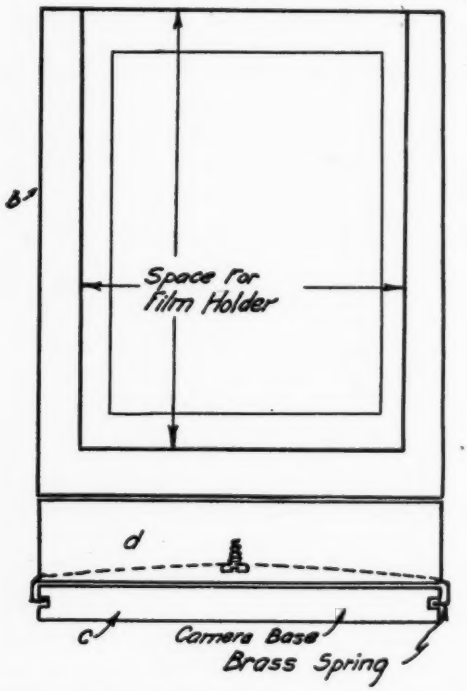


FIG. 3.—Method of attaching plateholder back to camera base, making possible addition of various camera segments.

The removable segments and the end segments are made of plywood. They are made with an inside rim to make the joints between the boxes fit with friction. The joints are covered with metal strips.

CAMERA MOUNTING

Figures 4 and 5 illustrate the apparatus. The camera is mounted on a rotating support which is pivoted upon a 2½-inch iron pipe passing through 2″×4″ pine end posts which are firmly attached and braced to a heavy base board about 2 feet square. As shown in figure 5, the camera is revolved about this axis between exposures. The angle of about 12 degrees is set with an adjustable stop.

ILLUMINATION BOX

The specimen is mounted above a box that serves as a substage illuminator. A white card is arranged to reflect the light of a 500-watt projection lamp, giving thus a white background for the fossil picture. This

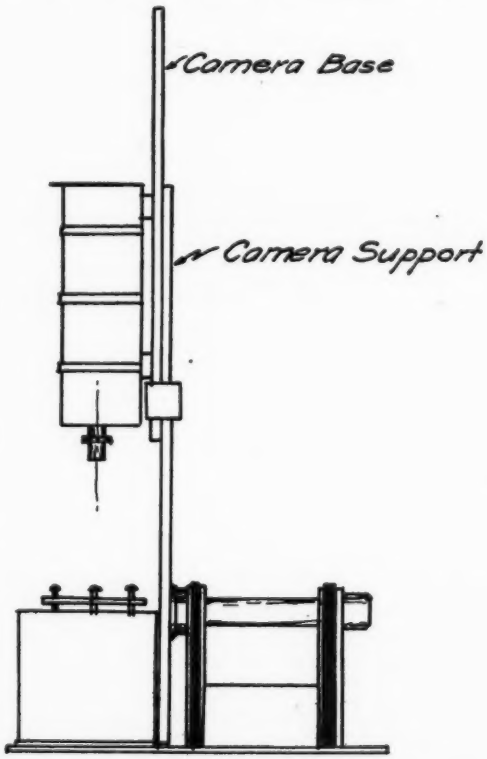
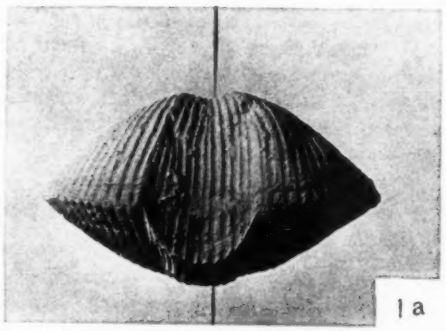
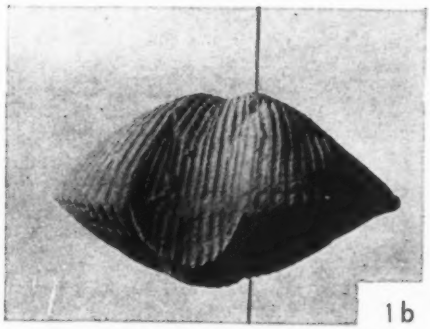


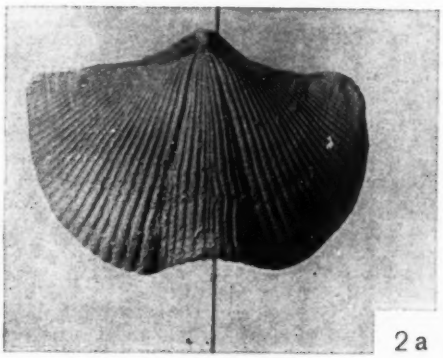
FIG. 4.—Side view of apparatus, showing axis of rotation, making possible rotation of camera around specimen.

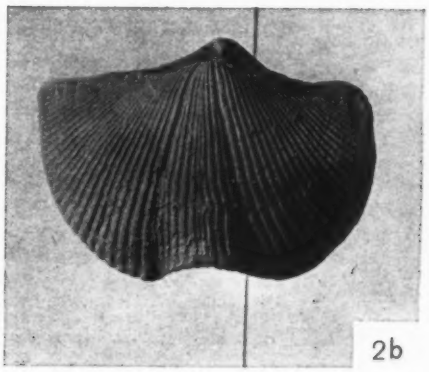
EXPLANATION OF PLATE 59

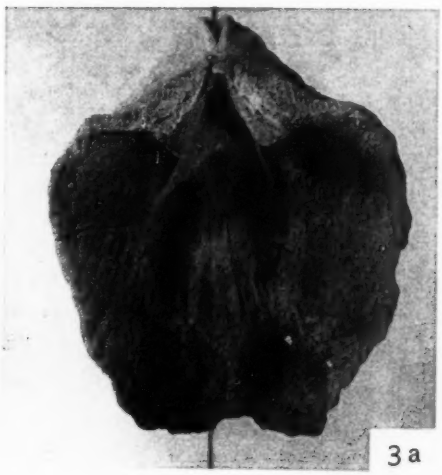
FIGS. 1–3.—Three views of *Spirifer*. 1. Anterior view of a specimen, ×1½. 2. Dorsal view of the same specimen, ×1½. 3. Interior of ventral valve of another species, ×3.

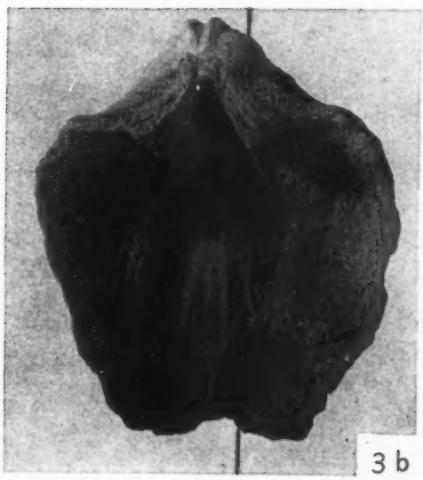












Gott—Stereophotography

arrangement of background is of especial value because it keeps the shadow of the fossil from appearing. A small electric fan may be used to cool off the box by forced ventilation if desired. A small light globe in series with a 110-volt fan will serve as a resistance to make it run more slowly, cutting down vibration (figs. 6 and 7). The fan should not be in operation during exposure and the projection bulb should not be allowed to burn for more than 10 seconds at a time because of the heat it emits (fig. 6).

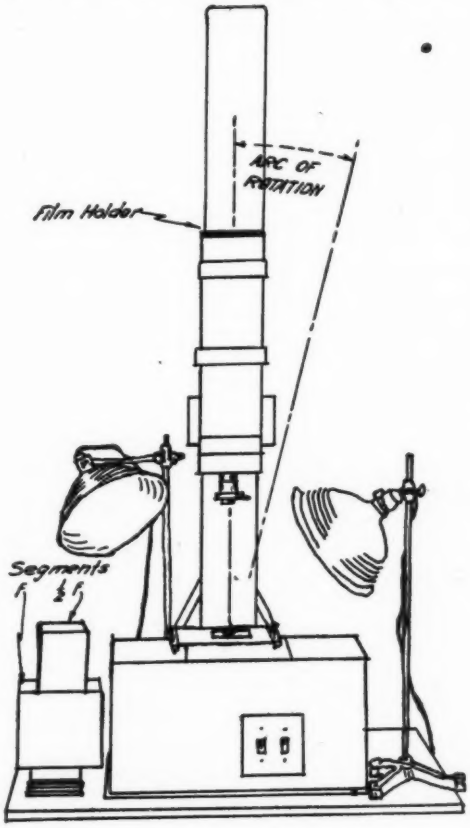


FIG. 5.—Front view of apparatus, showing arc through which the camera is rotated between exposures.

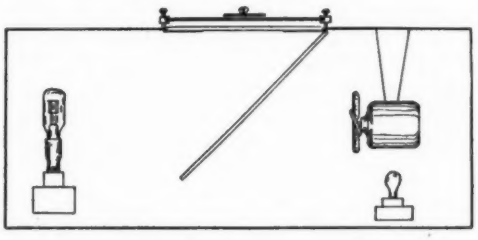


FIG. 6.—"Substage" illuminator, to give a white background to the pictures.

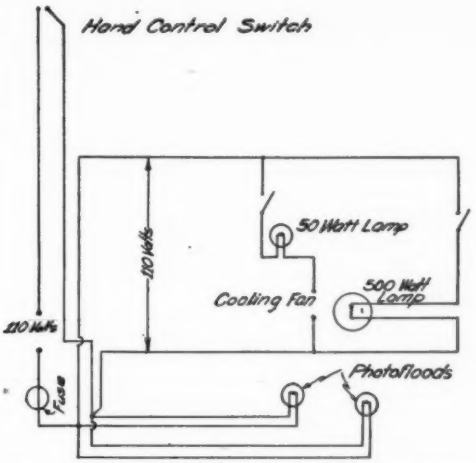


FIG. 7.—Diagram showing arrangement of electrical circuit for substage and surface lighting of specimens.

SUPPORT FOR FOSSILS

The fossils are supported in a position near the axis of rotation of the camera sys-

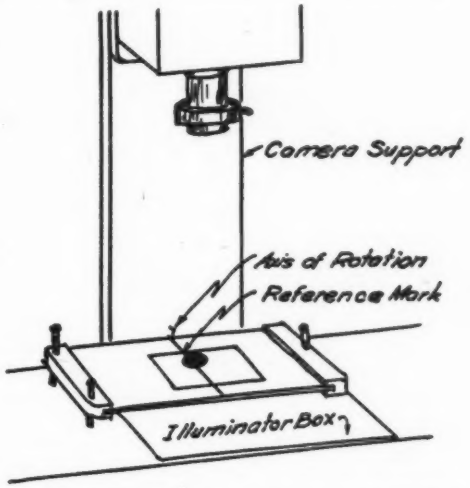


FIG. 8.—Arrangement of reference mark on glass table supporting the fossil. This mark shows the location of the axis of rotation.

tem upon a glass table whose height is set by three screws. A straight-line reference mark kept parallel to the axis of rotation is on the lower side of the glass table. The axis of rotation is marked on the rotating camera support with a tack. The height of the glass table and its location to the right or left is adjusted by aligning the reference mark under the tack. This line is perpendicular to the edge of the glass table so that pressing the glass table against the camera support makes the line parallel to the axis of rotation. The photograph of this line is used later in aligning the finished prints (fig. 8).

MOUNTING OF FOSSILS

The fossils are mounted with small lumps of modeling clay on thin glass plates three or four inches on edge. These handy units are easy to work with when coating the fossils with ammonium chloride, and are placed upon the glass table just described.

OPERATING CAMERA IN MAKING PAIR OF NEGATIVES

The sensitized material used in the camera is cut film or film pack. An advantage of film pack is that the successive films are numbered on the edge of each film by the manufacturer. This will prevent confusion as to which films should go together when a number of similar fossils are photographed and the films are developed together.

In making exposures the order of procedure is as follows:

1. The fossil is mounted with modeling clay on a small glass plate. If a marble is to be used to give a comparison of shape with an object known to be spherical, it is mounted also.
2. The fossils and the marble are coated with ammonium chloride. In this operation, ammonium chloride in a glass tube is vaporized by heating the glass tube with a Bunsen burner. By blowing through the tube, this vapor is sprayed into the cool air where it condenses on the fossil. Care should be taken not to coat the glass. This vapor should not be inhaled. An electric fan blowing the vapor away from the worker is desirable.
3. This assembly, together with a small section of a scale, is placed on the glass table over the reference line.
4. The glass table is aligned with the axis of rotation by pressing the edge of the table against the movable camera support and then sliding it sidewise until the line on the glass coincides with a mark on the camera support indicating the axis of rotation.
5. Ground glass is inserted in the camera and, with the lights turned on, the fossil assembly is placed in the center of the field of view. The field is checked with the camera in both upright and tilted positions. If the camera is not set to the correct magnification and focus, this is done now. The correct number of segments is placed between the end pieces; for example, to give $1\frac{1}{2}$ magnification, put in enough segments to have their length equal $1\frac{1}{2}$ f. The camera is focused by sliding it up and down the camera support.
6. Exposures are now made with the camera in the upright and in the tilted positions. The diaphragm is closed to a very small aperture, giving great depth of field. Each exposure is made by means of the illuminating lights, operated by a hand switch, shown in figure 7.

PROCESSING THE FILM

The films thus exposed are now ready to be developed. The developing technique may be time-temperature processing to give uniform negatives under standard conditions of exposure and light. If this technique is used, the making of negatives is standardized, once the exposure and development giving the correct contrast and density have been determined. In any case a set of experimental exposures should be made to find the right exposure time.

In order to keep the two negatives together, they may be bound together at one edge with scotch tape. The tape should be on the back of the films so as not to separate the film from the paper in making prints.

PRINTING

Glossy paper should be used, and it should be dried on a ferrotype plate.

It is recommended that the two negatives

be printed at the same time on the same piece of sensitized paper. If the negatives have been exposed for equal times and developed together, there should be no difficulty in producing the same print quality

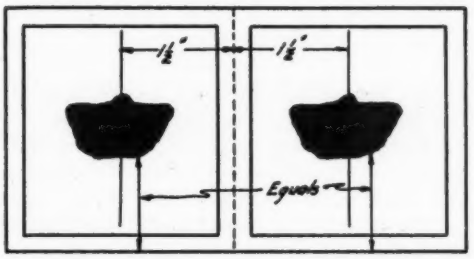


FIG. 9.—Diagram showing stereo prints, illustrating use of reference marks in aligning prints for mounting.

in each print. Having the two views attached is of particular use when a number of prints of similar fossils are processed together.

MOUNTING THE STEREO PRINTS

A stereo pair when mounted must be correctly separated and aligned. The correct arrangement of the two prints on the card is shown in figure 9. First, the center line (c) and (c') must be 1½ inches from the vertical line in the center of the card. Second, all corresponding parts of the two pictures must be at the same height from the bottom of the card.

In short, the two prints should be so related that one image could be brought in coincidence with the other by sliding it a distance of 3 inches along the base of the mount.

Each print contains the reference line under the fossil, marking the axis of rotation. The print made in the tilted position has in the edge of its field a saw-toothed marker that comes into the field of the camera when it is tilted. This print is to be mounted to the right. The prints are marked in the making so the right and left views are distinguished, and each may be properly spaced and aligned by the reference mark.

Dry mounting tissue is recommended to attach the print. If dry mounting tissue cannot be used conveniently, due to lack of equipment, glue may be substituted. Rubber cement should never be used for permanent mounts. After a time sulphur contained in the rubber will tend to react with the silver of the image, toning the print a mottled brown. Later the cement will deteriorate and release the print.

MOUNTING STEREOPHOTOGRAPHS

Prints are mounted on a page with lines running from the top to the bottom of the page and three inches apart. The reference marks on the prints are placed directly on top of the parallel lines and the vertical location is measured from the bottom of the page.

VIEWING

The ordinary stereoscope may be used to view the stereograms. If the pictures are mounted on a standard 3½″×7″ card, the stereoscope is used as is customary. If photographs mounted on a page are to be viewed, the stereoscope must be modified.

The closest point of comfortable vision is found and the stereoscope support for the card is cut off there. Either a base may be constructed to hold the stereoscope above the page at an adjustable height, or the stereoscope may be held in the hand.

In illustration of the results which are obtainable by this process, stereograms on plate 59 are submitted for viewing with a stereoscope. The fossils are in the Plummer Collection at the University of Texas.

MANUSCRIPT RECEIVED OCTOBER 30, 1944.

JOURNAL OF PALEONTOLOGY, VOL. 19, NO. 4, PP. 396–410, JULY 1945

BIBLIOGRAPHY AND INDEX TO NEW GENERA, SPECIES, AND VARIETIES OF FORAMINIFERA FOR THE YEAR 1942

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THE FOLLOWING bibliography lists 146 publications devoted exclusively or partly to Foraminifera. For the year 1942 a total of 116 titles are recorded. Additional publications of previous years are added as follows: 6 for 1939, 5 for 1940, and 19 for 1941.

Papers numbered 14, 121 and 145 were not available to the author. No details can, therefore, be given as to new species, pagination, plates, figures and geologic age. Parr's paper, included in the following bibliography between numbers 72 and 73 was listed in the bibliography for 1941, published in this Journal, vol. 18, No. 4, July 1944 on page 391, no. 93. Its three new genera were recorded in that bibliography.

Publications in the following bibliography, in which new forms of Foraminifera are described, are, as follows: 5, 8, 10, 12–15, 16, 19, 22, 24, 25, 27–31, 34, 35, 37–40, 47, 58, 86, 93, 96–98, 103, 104, 106, 110, 121, 123, 129, 131, 133, 144, and 145, a total of 41.

In the literature for the year 1942 there are recorded one new family, one new subfamily, 15 new genera, 4 new subgenera, 164 new species, 25 new varieties (or subspecies), 4 new names, 5 *nomina nuda*, 6 homonyms, and 72 forms to which the *nomenclatura aperta* has been applied. Two new forms are added for the year 1940; 2 new genera and 4 new species are added for the year 1941.

Stratigraphically the new genera are distributed as follows: Silurian 4, Carboniferous 3, Permo-Carboniferous 1, Cretaceous 6, and Eocene-Recent 1. They are allocated to the following families: Fusulinidae 4, "Rotaliiformes" 6, Valvulinidae 1, and Saccamminidae 4.

Out of a total of 189 new species and varieties of Foraminifera 45.5 per cent are from Cenozoic, 8.5 from Mesozoic, and 46 from Paleozoic strata. The Silurian accounts for 29 per cent, Carboniferous 14, Permian 3, Cretaceous 8.5, Eocene 20.5, Oligocene 2.5, Miocene 8, Pliocene 6.5, Pleistocene and Subrecent .5, and Recent 7.5 of all the newly described forms. No new species were recorded during 1942 from Cambrian or Jurassic beds.

I wish to express my thanks to Dr. J. A. Cushman, Miss Ruth Todd, Miss Irene Crespin, Mr. W. J. Parr, and Dr. H. H. Renz for their kind cooperation in assembling the data for this bibliography and index, and to Mrs. Heidi Thalmann for her assistance in collating the manuscript. Dr. Don L. Frizzell checked the bibliography.

Homonyms.—The following names, published during 1942, are homonyms and, therefore, substitute names should be proposed by their respective authors:

Ammodiscus minutus Dunn, preoccupied by Paalzow, 1932, and by Ireland, 1939;
Marginulina multiplicata Bergquist, preoccupied by Bornemann, 1854;
Proteonina? ovata Dunn, preoccupied by Cushman, 1910;
Psammosphaera subsphaerica Dunn, preoccupied by Stewart and Priddy, 1941;
Uvigerina gallowayi Coryell and Mossman, preoccupied by Cushman, 1929;
Uvigerina striata attenuata Coryell and Mossman, Preoccupied by Cushman and Renz, 1941.

Some homonyms, dating from 1940, should also be corrected, namely:

Lagena nucelloides corrosa Buchner, 1940, preoccupied by Buchner's *Lagena corrosa* 1940;
Listerella laevis Cushman, 1940, preoccupied by Finlay, 1939, which should be allocated to the genus *Schenckiella* Thalmann, 1942;
Planularia cushmani Palmer, 1940, preoccupied by Kleinpell, 1938, Miocene Stratigraphy of California, p. 207;
Planularia cushmani ornata Palmer, 1940, preoccupied by *Cristellaria* (*Planularia*) *ornata* Terquem, 1858.

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Ammobaculites subplanatus Cushman and Deaderick, **24**, p. 52, pl. 9, figs. 10, 11. Upper Cretaceous, Arkansas.

Ammodiscus brevitubus Dunn, **35**, p. 339, pl. 44, fig. 24. Upper Silurian, Illinois.

——— *constrictus* Dunn, **35**, p. 339, pl. 44, fig. 27, Upper Silurian, Illinois.

——— *minutus* Dunn, **35**, p. 339, pl. 44, fig. 28. Upper Silurian, Missouri. (Note: The species name is already preoccupied by Paalzow, 1932, Verh. vaterl. Ver. Naturkde Wurttemberg, Jahresber., vol. 88, p. 93, pl. 4, figs. 10, 11, from Argovian beds of Germany; as a subspecies name it is already preoccupied by Ireland, 1939, Jour. Paleontology, vol. 13, p. 200, figs. B-20 and B-21, from the Silurian of Oklahoma: *A. abbreviatus* Cushman, 1910, var. *minutus* Ireland.)

Ammosphaeroides scotti Dunn, **35**, p. 335, pl. 44, fig. 14. Upper Silurian, Missouri.

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——— ——— ——— var. *yazooensis* Bergquist, **5**, p. 81, pl. 8, figs. 16, 17. Eocene (Jackson), Mississippi.

Anomalina basilobata Cushman and Renz, **27**, p. 12. pl. 3, fig. 7. Eocene, Soldado Rock, Trinidad.

Anomalina sholtzensis Cole, **12**, p. 34, pl. 2, figs. 1, 2. Upper Cretaceous (Selma), Florida.

ANOMALINOIDES gen. nov., Brotzen, **8**, p. 23. Fam. Rotaliiformes. Genotype: *Anomalinoides plummerae* Brotzen, 1942, ut infra. Upper Cretaceous.

——— *plummerae* nov. nom. Brotzen, **8**, p. 23. For: *Anomalina grosserugosa* Plummer, 1931, (non Gümbel, 1868, *Truncatulina*), Univ. Texas Bull. 3101, p. 201, pl. 14, fig. 9 (non fig. 7). Upper Cretaceous, Texas.

APPLINELLA subgen. nov. Thalmann, **96**, p. 812. Subgenus of *Hantkenina* Cushman, 1924. Subgenotype: *Hantkenina dumblei* Weinzierl and Applin, 1929, Jour. Paleontology, vol. 3, p. 402, pl. 43, fig. 5, Eocene, Texas. Family: Hantkeninidae (Cushman), or Nonionidae (Galloway). Middle Eocene (Lutetian).

ARAGONELLA subgen. nov. Thalmann, **96**, p. 811. Subgenus of *Hantkenina* Cushman, 1924. Subgenotype: *Hantkenina mexicana* Cushman, 1924, var. *aragonensis* Nuttall, 1930, Jour. Paleontology, vol. 4, p. 284, pl. 24, fig. 1, Lower Eocene, Mexico. Family: Hantkeninidae (Cushman), or Nonionidae (Galloway). Lower and Middle Eocene (Ypresian and Lutetian).

Asterigerina cedarkeysensis Cole, 12, p. 32, pl. 1, figs. 9, 10. Upper middle Eocene, Florida.

Bathysiphon parallelus Dunn, **35**, p. 322, pl. 42, fig. 1. Lower upper Silurian, Missouri.

Bifarina hancocki Cushman and McCulloch, **25**, p. 225, pl. 28, figs. 13–19. Recent, Pacific, near La Libertad, Ecuador, depth 19 fathoms.

——— *pacifica* Cushman and McCulloch, **25**, p. 225, pl. 28, fig. 20. Recent, Port Parker, Costa Rica, depth 5 fathoms.

Bolivina acerosa Cushman, 1936, var. *pacifica* Cushman and McCulloch, **25**, p. 185, pl. 21, figs. 2, 3. Recent, Pacific, Gulf of California off Mexico, depth 10 fathoms.

——— *britannica* Macfadyen, **58**, p. 143. Post-Glacial, England. For: *Textularia variabilis* Williamson, 1858, var. *laevigata* Williamson, 1858 (non d'Orbigny, 1846), Ray Soc. p. 77, pl. 6, fig. 168; and for *Bolivina laevigata* (Williamson) in Cushman, 1937, Cushman Lab. Foram. Research, Spec. Publ., vol. 9, p. 159, pl. 16, figs. 1–5.

——— *dottiana* Coryell and Mossman, **15**, p. 239, pl. 36, fig. 33. Pliocene, Panama.

——— *gladius* Garrett, **39**, p. 462, pl. 70, fig. 8. Miocene, Texas.

——— *pomposa* Coryell and Mossman, **15**, p. 241, pl. 36, fig. 39. Pliocene, Panama.

——— *quadrata* Cushman and McCulloch, **25**, p. 205, pl. 25, fig. 13. Recent, Pacific, off Guadalupe Island, depth 18 fathoms.

——— *seminuda* Cushman, 1911, var. *humilis* Cushman and McCulloch, **25**, p. 211, pl. 26, figs. 1–6. Recent, Pacific, off Mexico, depth 160 fathoms.

——— *spinata* Galloway and Wissler, 1927, var. *praevia* Coryell and Mossman, **15**, p. 242, pl. 36, fig. 41. Pliocene, Panama.
——— *tongi* Cushman, 1929, var. *filacostata* Cushman and McCulloch, **25**, p. 214, pl. 27, figs. 7–11. Recent, Pacific, off Galapagos Islands, depth 80 fathoms.
——— *torqueata* Cushman and McCulloch, **25**, p. 215, pl. 27, figs. 5, 6. Recent, Pacific, off Charles Island, depth 9 fathoms.
——— *westi* Garrett, **39**, p. 462, pl. 70, fig. 6. Miocene, Texas.
Bulimina kugleri Cushman and Renz, **27**, p. 9, pl. 2, fig. 9. Eocene, Soldado Rock, Trinidad.
——— *parkerae* Thalmann, (nom. nov.), **98**, p. 464. For: *Bulimina elegans* Brady, 1884, (non d'Orbigny, 1826), Challenger Repts., Zool., vol. 9, pl. 50, figs. 1–4. Recent.
Buliminella madagascariensis (d'Orbigny, 1826), var. *spicata* Cushman and Parker, (nom. nov.), **19**, p. 8, pl. 3, figs. 5, 6. Recent, Pacific, off Fiji, depth 40–50 fathoms. For: *Bulimina elegantissima* d'Orbigny, 1839, var. *apiculata* Chapman, 1907, (non Egger, 1895), Jour. Linn. Soc. London, (Zool.), vol. 30, p. 31, pl. 4, fig. 77; and for same species and variety in Sidebottom, 1918, Jour. Roy. Micr. Soc. London, p. 23, pl. 3, fig. 11; for: *Buliminella apiculata* Cushman, 1929, Contr. Cushman Lab. Foram. Research, vol. 5, p. 44, pl. 7, figs. 6, 7; and for same species in Cushman and Parker, 1937, Contr. Cushman Lab. Foram. Research, vol. 13, p. 39, pl. 4, fig. 10.
Cancris auriculus (Fichtel and Moll, 1803) var. *primitivus* Cushman and Todd, **31**, p. 77, pl. 19, figs. 1, 2. Oligocene, Germany.
——— *baggi* Cushman and Kleinpell, 1934, var. *planus* Cushman and Todd, **31**, p. 84, pl. 21, fig. 11. Upper middle Miocene, Florida.
——— *intermedius* Cushman and Todd, **31**, p. 88, pl. 22, figs. 11, 12. Miocene, Victoria, Australia. For: *Cancris auricula* Chapman, Parr and Collins, 1934 (non Fichtel and Moll, 1803), Jour. Linn. Soc., Zool., vol. 38, p. 567, pl. 10, fig. 24.
——— *mauryae* Cushman and Renz, **27**, p. 11, pl. 2, fig. 17. Eocene, Soldado Rock, Trinidad.
——— *mexicanus* Cushman and Todd, **31**, p. 93, pl. 24, figs. 8–11. Oligocene (Alazan), Mexico. For: *Cancris sagra* Nuttall, 1932, (non d'Orbigny, 1839), Jour. Paleontology, vol. 6, p. 27, pl. 6, figs. 6, 7.
——— *ovatus* Cushman and Todd, **31**, p. 89, pl. 23, figs. 1, 2. Oligocene, Victoria, Australia.
——— *sagra* (d'Orbigny, 1839) var. *communis* Cushman and Todd, **31**, p. 79, pl. 19, figs. 8–11; pl. 20, fig. 1. Miocene, Florida. For: *Pulvinulina sagra* Cushman, 1918, (non d'Orbigny, 1839), U. S. Geol. Surv., Bull. 676, p. 65, pl. 22, fig. 3; pl. 23, fig. 1; for same species in Cushman, 1918, U. S. Nat. Mus., Bull., 103, p. 70, pl. 24, fig. 6; for: *Cancris sagra* in Cushman, 1930, Florida Geol. Surv. Bull. 4, p. 56, pl. 11, fig. 4; for same species in Cushman and Ponton, 1932, Florida Geol. Surv. Bull. 9, p. 94, pl. 14, fig. 3; for same species in Ellisor, 1940, Am. Assoc. Petroleum Geologists, Bull., vol. 24, pl. 6, fig. 6; for: *Cancris auricula* Cushman, 1927 (non Fichtel and Moll, 1803), Scripps Inst. Oceanogr., Bull., Tech. Series, I, Nr. 10, p. 164, pl. 5, fig. 10; and for same species in Cushman and Valentine, 1930, Dept. Geol. Stanford Univ., Contr., vol. 1, No. 1, p. 25, pl. 8, fig. 1.
——— *torquertus* Cushman and Todd, **31**, p. 87, pl. 22, figs. 9, 10. Recent, Pacific, Sombrero Island, Philippines, depth 200 fathoms.
——— *tumidus* Cushman and Todd, **31**, p. 93, pl. 24, figs. 5–7. Miocene, Egypt. For: *Pulvinulina indica* Macfadyen, 1931, (non Cushman, 1921), Geol. Surv. Egypt, p. 101, pl. 4, fig. 13.
——— *turgidus* Cushman and Todd, **31**, p. 92, pl. 24, figs. 3, 4. Oligocene, Germany. For: *Pulvinulina haueri* Franke, 1925, (non d'Orbigny, 1846), Abh. Ber. Mus. Naturw. Heimatkde, vol. 4, part 2, p. 183, pl. 6, fig. 58.
Cibicides americanus (Cushman, 1918) var. *jacksonensis* Bergquist, **5**, p. 100, pl. 10, figs. 17, 18. Eocene (Jackson), Mississippi.
——— *steini* Garrett, **39**, p. 463, pl. 70, fig. 5. Miocene, Texas.
——— *terryi* Coryell and Mossman, **15**, p. 237, pl. 36, figs. 21, 22. Pliocene, Panama.
Clavulina floridana Cole, **12**, p. 17, pl. 2, figs. 6, 7. Lower Middle Eocene, Florida.
Colonammina bituba Dunn, **35**, p. 336, pl. 46, fig. 16. Upper Silurian, Missouri.
Coskinolina elongata Cole, **12**, p. 20, pl. 3, figs. 15–17; pl. 4, figs. 1–3; pl. 5, figs. 2–7; pl. 16, fig. 6. Lower middle Eocene, Florida.
Cribrobulimina floridana Cole, **12**, p. 17, pl. 1, figs. 7, 8. Middle Eocene, Florida.
Cribrogenerina krizi Cushman, **22**, p. 67, pl. 16, figs. 1–7. Permian, Texas.
CRIBROHANTKENINA subgen. nov., Thalmann, **96**, p. 812. Subgenus of *Hantkenina* Cushman, 1924. Fam. Hantkeninidae (Cushman) or Nonionidae (Galloway). Subgenotype: *Hantkenina* (*Cribrohantkenina*) *bermudezi* Thalmann, 1942, ut infra. Upper Eocene (Ledian and Wemmelian).
CRONEISELLA gen. nov., Dunn, **35**, p. 334. Fam. Saccamminidae, subfam. Saccammininae Genotype: *Croneisella typa* Dunn, 1942, ut infra. Middle Silurian.
——— *typa* Dunn, **35**, p. 335, pl. 44, figs. 10, 11. Middle Silurian, Illinois and Missouri.
Darbyella brownstownensis Cushman and Deaderick, **24**, p. 56, pl. 11, figs. 1–3. Upper Cretaceous, Arkansas.
Dentalina basiplanata Cushman, 1938, var *subsetigera* Cushman and Deaderick, **24**, p. 58, pl. 11, figs. 5, 6. Upper Cretaceous, Arkansas.
——— *delicatula* Cushman, 1938, var. *naheolensis* Cushman and Todd, 30, p. 30, pl. 5, figs. 14, 15. Eocene (Naheola), Alabama.
Discorbis bolivarensis Garrett, **39**, p. 462, pl. 70, figs. 1, 2. Miocene, Texas.
——— *inornatus* Cole, **12**, p. 30, pl. 1, figs. 1–3. Upper middle Eocene, Florida.
——— *midwayensis* Cushman, 1940, var. *soldadoensis* Cushman and Renz, **27**, p. 10, pl. 3, fig. 4. Eocene, Soldado Rock, Trinidad.

——— ——— ——— var. *trinitatensis* Cushman and Renz, **27,** p. 10, pl. 3, fig. 5. Eocene, Soldado Rock, Trinidad.

——— *posidonicola* Colom, **14,** Recent, Mediterranean, Mallorca. Publication not seen.

——— *stenzeli* Garrett, **40,** p. 484, text fig. 1. Middle Eocene, Texas.

——— *suturalis* Cole, **12,** p. 30, pl. 2, figs. 3, 4. Lower middle Eocene, Florida.

DUNBARINELLA gen. nov., Thompson, **106,** p. 416, Fam. Fusulinidae. Genotype: *Dunbarinella ervinensis* Thompson, 1942, ut infra. Upper Pennsylvanian and Permian.

——— *ervinensis* Thompson, **106,** p. 419, pl. 3, figs. 1–9. Upper Pennsylvanian, Oklahoma.

Ellipsopleurostomella stewarti Cushman and Siegfus, **28,** p. 416, pl. 19, figs. 13, 14. Middle Eocene, California.

Elphidium maioricense Colom, **14,** Recent, Mediterranean, Mallorca. Publication not seen.

Endothyra bunkerae Coryell and Rozanski, **16,** p. 139, pl. 23, fig. 1. Pennsylvanian, Illinois.

Eponides gunteri Cole, **12,** p. 31, pl. 1, figs. 4–6. Upper middle Eocene, Florida.

Frondicularia naheolensis Cushman and Todd, **30,** p. 33, pl. 6, figs. 5, 6. Eocene (Naheola), Alabama.

Fusulina acme Dunbar and Henbest, **34,** p. 122, pl. 15, figs. 1–18; pl. 16, fig. 14. Pennsylvanian (Lonsdale limestone), Illinois.

——— *illinoisensis* Dumbar and Henbest, **34,** p. 118, pl. 11, figs. 18–30; pl. 12, fig. 9; pl. 13, figs. 1–12. Pennsylvanian (Brereton limestone), Illinois.

——— *knighti* Dunbar and Henbest, **34,** p. 112, pl. 6, figs. 14–21, Pennsylvanian (Fort Scott limestone), Missouri, and Bankston Fork limestone, Illinois.

——— *levicula* Dunbar and Henbest, **34,** p. 104, pl. 4, figs. 12–19. Pennsylvanian, Illinois.

——— *lonsdalensis* Dunbar and Henbest, **34,** p. 125, pl. 16, figs. 1–13, 15–21. Pennsylvanian (Lonsdale limestone), Illinois.

——— *piasaensis* Dunbar and Henbest, **34,** p. 129, pl. 18, figs. 4–9. Pennsylvanian (Piasa limestone), Illinois.

——— *spissiplicata* Dunbar and Henbest, **34,** p. 105, pl. 7, figs. 1–12. Pennsylvanian, Illinois.

Fusulinella cadyi Dunbar and Henbest, **34,** p. 96, pl. 4, figs. 20–28. Pennsylvanian (Abshar limestone), Illinois.

——— *gephyrea* Dunbar and Henbest, **34,** p. 96, pl. 3, figs. 1–6. Pennsylvanian (Seville limestone), Illinois.

GASTROAMMINA gen. nov., Dunn, **35,** p. 335. Fam. Saccamminidae; subfam. Saccamminae. Genotype: *Gastroammina williamsae* Dunn, 1942, ut infra. Upper Silurian.

——— *williamsae* Dunn, **35,** p. 335, pl. 44, fig. 35. Upper Silurian, Missouri.

Gaudryina soldadoensis Cushman and Renz, **27,** p. 4, pl. 1, fig. 2. Eocene, Soldado Rock, Trinidad.

GAVELINELLA gen. nov., Brotzen, **8,** p. 7, 41. Fam. Rotaliiformes Brotzen. Genotype: *Discorbina pertusa* Marsson, 1878, Mitt. Naturw. Ver. Neu-Vorpommern und Rügen, vol. 10, p. 166, pl. 4, fig. 35. Middle and Upper Cretaceous.

——— *baltica* Brotzen, **8,** p. 50, pl. 1, fig. 7. Uppermost Cenomanian, Pommerania, Germany.

——— *bullata* Brotzen, **8,** p. 45, pl. 1, figs. 4, 5. Uppermost Danian, Schonen, Sweden.

——— *costata* Brotzen, **8,** p. 43, pl. 1, fig. 3. Lower Campanian, Sweden.

——— *tomarpensis* Brotzen, **8,** p. 52, pl. 1, fig. 6. Uppermost Gault, Halland, Sweden.

——— *tumida* Brotzen, **8,** p. 47, text fig. 15. Emscherian-Senonian, Eriksdal, Sweden. For: *Anomalina lorneiana* Brotzen, 1936, (non d'Orbigny, 1840, *Rosalina*), Sverig. Geol. Undersök. Arsbok 30, no. 3, p. 178, pl. 12, figs. 1, 2, text fig. 64.

Globorotalia crassata (Cushman, 1925), var. *aequa* Cushman and Renz, **27,** p. 12, pl. 3, fig. 3. Eocene, Soldado Rock, Trinidad.

GLOBOROTALITES gen. nov., Brotzen, **8,** p. 31. Fam. Rotaliiformes Brotzen, Genotype: *Globorotalia multisepta* Brotzen, 1936, Sverig. Geol. Undersök. Arsbok 30, no. 3, p. 161, pl. 11, figs. 6, 7; text figs. 59–61. Upper Cretaceous.

Globotruncana renzi Thalmann, **103,** p. 51. Turonian, Italy. For: Fig. 2 on pl. 8 in O. Renz, 1936, Eclog. geol. Helv., vol. 29, profile 2, layer 12.

Gümbelina trinitatensis Cushman and Renz, **27,** p. 8, pl. 2, fig. 8. Eocene, Soldado Rock, Trinidad.

Gyroidina cretosa Cole, **12,** p. 31, pl. 2, figs. 11, 12. Upper Cretaceous (Selma), Florida.

——— *soldani* d'Orbigny, 1826, var. *multilocula* Coryell and Mossman, **15,** p. 237, pl. 36, fig. 20. Pliocene, Panama.

GYROIDINOIDES gen. nov., Brotzen, **8,** p. 19. Fam. Rotaliiformes Brotzen. Genotype: *Rotalina nitida* Reuss, 1845. Böhm. Kreide, vol. 1, p. 35, pl. 8, fig. 52; pl. 12, figs. 8 and 20. Cenomanian and Turonian.

HANTKENINA subgen. nov. Thalmann, **96,** p. 811. Subgenus of *Hantkenina* Cushman, 1924. Fam. Hantkeninidae Cushman, or Nonionidae Galloway. Subgenotype: *Hantkenina alabamensis* Cushman, 1924, U. S. Nat. Mus., Proc., vol. 66, Art. 30, p. 3, pl. 1, figs. 1–6; test fig. 1. Eocene (Lutetian to Wemmelian).

Hantkenina (*Cribrohantkenina*) *bermudezi* Thalmann, **96,** p. 812. Nom. nov. for: *Hantkenina* (*Sporohantkenina*) *brevispina* Bermudez, 1937 (non *Hantkenina* brevispina Cushman, 1924), Soc. Cubana Hist. Nat., Mem., vol. 11, p. 151, pl. 19, figs. 7–10; and for same species, renamed *Hantkenina* (*Sporohantkenina*) *bermudezi* Thalmann, **104,** p. 49. Upper Eocene, Cuba.

Hyperammina sublaevigata Dunn, **35,** p. 337, pl. 44, fig. 6. Upper Silurian, Missouri.

Lagena howei Bergquist, **5,** p. 50, pl. 5, fig. 19. Eocene (Jackson), Mississippi. For: *Lagena sp.* (*C*) Howe and Wallace, 1932, Louisiana Dept. Conserv., Geol. Bull. no. 2, p. 31, pl. 6, fig. 6.

Lagenammina bulbosa Dunn, **35,** p. 327, pl. 42, figs. 21 and 26. Middle Silurian, Illinois.

——— *urniformis* Dunn, **35,** p. 328, pl. 43, fig. 4. Upper Silurian, Missouri.

Lamarckina limbata Cushman and Todd, **30,** p. 39, pl. 7, figs. 8–10. Eocene (Naheola), Alabama.

——— *naheolensis* Cushman and Todd, **30,** p. 39, pl. 7, figs. 5–7. Eocene (Naheola), Alabama.

Laticarinina bullbrooki Cushman and Todd, **29,** p. 19, pl. 4, figs. 8, 9. Miocene, Trinidad.

——— *crassicarinata* Cushman and Todd, **29,** p. 18, pl. 4, figs. 11, 12. Recent, Pacific, off Philippine Islands, depth 494 fathoms. For: *Pulvinulina pauperata* Cushman, 1921 (non Parker and Jones, 1865), U. S. Nat. Mus., Bull. 100, pt. 4, p. 340.

Lenticulina hanseni Garrett, **39,** p. 461, pl. 70, figs. 9, 10. Miocene, Texas.

Lepidocyclina (*Lepidocyclina*) *californica* Schenck and Childs, **86,** p. 17, pl. 1, figs. 1–4; pl. 2, figs. 1–4; pl. 3, figs. 1–9; pl. 4, figs. 1–6. Upper Oligocene (Vaqueros), California.

——— (*Pliolepidina*) *cedarkeysensis* Cole, 12, p. 43, pl. 3, figs. 1, 2; pl. 8, fig. 11; pl. 11, figs. 6, 7; pl. 12, figs. 1–7. Upper middle Eocene, Florida.

Lepidorbitoides (*Lepidorbitoides*) *floridensis* Cole, **12,** p. 37, pl. 9, figs. 5, 6. Upper Cretaceous (Selma), Florida.

Linderina floridensis Cole, **12,** p. 36, pl. 11, fig. 8; pl. 15, figs. 7–11. Eocene, Florida.

Lituonella elegans Cole, **12,** p. 19, pl. 3, fig. 7; pl. 5, figs. 9, 10; pl. 16, figs. 5 and 9. Lower Middle Eocene, Florida.

Lituotuba elongata Dunn, **35,** p. 340, pl. 44, fig. 36. Upper Silurian, Missouri.

——— *salinensis* Dunn, **35,** p. 340, pl. 44, fig. 29. Upper Silurian, Illinois.

Lituotuba? furca Dunn, **35,** p. 340, pl. 44, fig. 34. Upper Silurian, Illinois.

Lockhartia bermudezi Cole. **13,** p. 641, pl. 92, figs. 1–5. Upper Cretaceous, Cuba.

Loxostoma instabile Cushman and McCulloch, **25,** p. 221, pl. 27, figs. 15–17; pl. 28, figs. 1–7. Recent, Pacific, off Guadalupe Island, depth 250 fathoms.

Marginulina multiplicata Bergquist, **5,** p. 37, pl. 4, fig. 14. Eocene (Jackson), Mississippi. (Note: According to Ellis and Messina, Catalogue of Foraminifera, the species name is preoccupied by: *Orthocerina* (*Marginulina*) *multiplicata* Bornemann, 1854).

MILLERELLA gen. nov., Thompson, **106,** p. 404. Fam. Fusulinidae. Genotype: *Millerella marblensis* Thompson, 1942, ut infra. Pennsylvanian.

——— *marblensis* Thompson, **106,** p. 405, pl. 1, figs. 3–14. Pennsylvanian, Texas.

Nonionella soldadoensis Cushman and Renz, **27,** p. 7, pl. 2, fig. 7. Eocene, Soldado Rock, Trinidad. For: *Nonionina turgida* Plummer, 1927, (non Williamson, 1858), Univ. Texas Bull. 2644, p. 159, pl. 12, fig. 6.

Nubecularia massutiana Colom, **14,** Recent, Mediterranean, Mallorca. Publication not seen.

Planularia danvillensis Howe and Wallace, 1932, var. *yazooensis* Bergquist, **5,** p. 34, pl. 3, figs. 8, 9. Eocene (Jackson), Mississippi.

Planulina cedarkeysensis Cole, **12,** p. 35, pl. 2, figs. 13, 14. Upper Cretaceous (Selma), Florida.

——— *palmerae* Garrett, **39,** p. 463, pl. 70, figs. 3, 4. Miocene, Texas.

Proteonina acuta Dunn, **35,** p. 326, pl. 43, fig. 3. Upper Silurian, Illinois.

——— *jolietensis* Dunn, **35,** p. 326, pl. 43, fig. 2. Lower Silurian, Illinois.

——— *ovata* Dunn, **35,** p. 327, pl. 43, fig. 6. Lower Silurian, Illinois. (Note: This species name is preoccupied by Cushman, 1910, U. S. Nat. Mus., Bull. 71, p. 43, text fig. 43, for a recent form from Hawaii.)

Psammosphaera arcuata Dunn, **35,** p. 323, pl. 42, figs. 14 and 24. Upper lower Silurian, Illinois.

——— *conjunctiva* Dunn, **35,** p. 323, pl. 42, fig. 28. Upper lower Silurian, Missouri.

——— *excerpta* Dunn, **35,** p. 323, pl. 42, figs. 7, 8. Upper lower Silurian, Illinois.

——— *gigantea* Dunn, **35,** p. 323, pl. 42, fig. 9. Upper Lower Silurian, Tennessee.

——— *minuta* Dunn, **35,** p. 323, pl. 42, figs. 10–12. Upper Silurian, Missouri.

——— *subsphaerica* Dunn, **35,** p. 323, pl. 42, fig. 13. Upper Silurian, Missouri. (Note: This species name is preoccupied by Stewart and Priddy, 1941, Jour. Paleont., vol. 15, p. 371, pl. 59, fig. 10.)

——— *? greenlandensis* Howell and Dunn, **47,** p. 639, pl. 91, figs. 1, 2. Lower Cambrian, East Greenland.

Pseudastrorhiza irregularis Dunn, **35,** p. 321, pl. 42, fig. 2. Lower Silurian, Illinois.

——— *regularis* Dunn, **35,** p. 321, pl. 42, figs. 3, 4. Middle Silurian, Illinois.

Pseudoschwagerina montanensis Frenzel and Mundorff, **38,** p. 680, pl. 99, figs. 1–8; pl. 100, figs. 7–11. Lower Permian, Montana.

PSEUDOSTAFFELLA gen. nov., Thompson, **106,** p. 407. Fam. Fusulinidae. Genotype: *Pseudostaffella needhami* Thompson, 1942, ut infra. Lower Pennsylvanian.

——— *needhami* Thompson, **106,** p. 411, pl. 1, figs. 15–20; pl. 3, figs. 10–14. Lower Pennsylvanian, New Mexico.

Pseudouvigerina naheolensis Cushman and Todd, **30,** p. 36, pl. 6, figs. 18, 19. Eocene (Naheola), Alabama.

PSEUDOVALVULINERIA gen. nov., Brotzen, **8,** p. 20. Fam. Rotaliiformes Brotzen. Genotype: *Rosalina lorneiana* d'Orbigny, 1840, Soc. géol. France, Mém., vol. 4, No. 1, p. 36, pl. 3, figs. 20–22. Upper Cretaceous.

Pullenia malkinae Coryell and Mossman, **15,** p. 234, pl. 36, figs. 3, 4. Pliocene, Panama.

Quinqueloculina plummerae Cushman and Todd, 30, p. 25, pl. 5, fig. 2. Eocene (Naheola), Alabama. For: *Quinqueloculina ferussacii* Plummer, 1927, (non d'Orbigny, 1826), Univ. Texas Bull. 2644, p. 161, pl. 12, fig. 10.

Robulus cushmani Galloway and Wissler, 1927, var. *procedendus* Coryell and Mossman, **15,** p. 243, pl. 36, figs. 1, 2. Pliocene, Panama.

Rotaliatina quadralocula Bergquist, **5,** p. 86, pl. 8, figs. 27, 28. Eocene (Jackson), Mississippi.

——— ——— ——— var. *elongata* Bergquist,

5, p. 87, pl. 8, fig. 30. Eocene (Jackson), Mississippi.

ROTALIIFORMES new family group, Brotzen, **8,** p. 1 ff. (Note: In this paper Brotzen deals with the systematics of this new family group.)

ROTALIPORA gen. nov., Brotzen, **8,** p. 32. Fam. Rotaliiformes Brotzen. Genotype: *Rotalipora turonica* Brotzen, 1942, ut infra. Upper Cretaceous, Turonian.

——— *turonica* Brotzen, **8,** p. 32, text figs. 10, 11. Lower Turonian, Pommerania, Germany.

SCHENCKIELLA gen. nov., Thalmann, **97,** p. 458. Fam. Valvulinidae. Genotype: *Clavulina primaeva* Cushman, 1913, U. S. Nat. Mus., Proc., vol. 44, p. 693, pl. 80, figs. 4, 5. For: *Listerella* Cushman, 1933, non *Listerella* Jahn, 1906. Eocene to Recent.

Schwagerina pavilionensis Thompson and Wheeler, **110,** p. 706, pl. 105, figs. 3–6. Permian, British Columbia.

——— ——— var. *acris* Thompson and Wheeler, **110,** p. 707, pl. 105, figs. 1, 2. Permian, British Columbia.

SHIDELERELLA gen. nov., Dunn, **35,** p. 328. Fam. Saccamminidae; subfam. Saccammininae. Genotype: *Shidelerella bicuspidata* Dunn, 1942, ut infra. Upper Silurian.

——— *bicuspidata* Dunn, **35,** p. 329, pl. 43, fig. 1. Upper Silurian, Illinois.

——— *cylindrica* Dunn, **35,** p. 329, pl. 43, fig. 7. Upper Silurian, Missouri.

——— *elongata* Dunn, **35,** p. 329, pl. 42, figs. 32, 33. Upper Silurian, Missouri.

Sigmomorphina floridana Cole, **12,** p. 26, pl. 1, figs. 11, 12. Upper middle Eocene, Florida.

——— *soldadoensis* Cushman and Renz, **27,** p. 7, pl. 2, fig. 5. Eocene, Soldado Rock, Trinidad.

Sorosphaera bicella Dunn, **35,** p. 325, pl. 42, figs. 17, 18. Upper Silurian, Missouri.

——— *multicella* Dunn, **35,** p. 325, pl. 42, fig. 19. Upper Silurian, Indiana.

——— *subconfusa* Dunn, **35,** p. 325, pl. 42, figs. 16 and 20. Upper Silurian, Missouri.

Spirillina obduxa Coryell and Rozanski, **16,** p. 139, pl. 24, fig. 27. Pennsylvanian, Illinois.

Stegnammina cylindrica Moreman, 1930, var. *brevis* Dunn, **35,** p. 325, pl. 42, fig. 25. Lower Silurian, Indiana.

THEKAMMINA gen. nov., Dunn, **35,** p. 326. Fam. Saccamminidae; subfam. Thekammininae. Genotype: *Thekammina quadrangularis* Dunn, 1942, ut infra. Lower Silurian.

——— *moremani* Dunn, **35,** p. 326, pl. 42, fig. 22. Upper lower Silurian, Missouri.

——— *quadrangularis* Dunn, **35,** p. 326, pl. 42, fig. 23. Upper lower Silurian, Illinois.

THEKAMMININAE subfam. nov., Dunn, **35,** p. 326. New subfamily of fam. Saccamminidae. Includes the genus *Thekammina* Dunn, 1942. Lower Silurian.

Tholosina ? dubia Dunn, **35,** p. 337, pl. 44, figs. 12, 13. Upper Silurian, Missouri.

Thurammina coronata Dunn, **35,** p. 331, pl. 43, fig. 18. Upper Silurian, Missouri.

——— *echinata* Dunn, **35,** p. 331, pl. 43, figs. 20, 21, and 23. Upper Silurian, Missouri, Illinois, Tennessee.

——— *foerstei* Dunn, **35,** p. 331, pl. 43, fig. 27. Lower Silurian, Illinois.

——— *hexagona* Dunn, **35,** p. 332, pl. 44, fig. 15. Upper Silurian, Illinois.

——— *inflata* Dunn, **35,** p. 332, pl. 43, figs. 37, 38. Upper Silurian, Missouri.

——— *jubata* Dunn, **35,** p. 332, pl. 44, fig. 17. Upper Silurian Illinois (not Missouri).

——— *limbata* Dunn, **35,** p. 332, pl. 43, fig. 34. Upper Silurian, Missouri.

——— ——— ——— var. *disciformis* Dunn, **35,** p. 332, pl. 43, fig. 39. Lower Silurian, Illinois.

——— *magna* Dunn, **35,** p. 333, pl. 43, fig. 10. Upper Silurian, Missouri.

——— *melleni* Dunn, **35,** p. 333, pl. 43, fig. 32. Upper Silurian, Illinois.

——— *parvituba* Dunn, **35,** p. 333, pl. 43, figs. 28, 29. Upper Silurian, Illinois and Missouri.

——— *quadrata* Dunn, **35,** p. 334, pl. 43, fig. 25. Upper Silurian, Missouri.

——— *quadritubulata* Dunn, **35,** p. 334, pl. 43, fig. 22. Upper Silurian, Missouri.

——— *slocomi* Dunn, **35,** p. 333, pl. 43, figs. 8 and 12. Upper Silurian, Illinois.

——— *splendens* Dunn, **35,** p. 334, pl. 43, fig. 30. Upper Silurian, Missouri.

——— *stelliformis* Dunn, **35,** p. 334, pl. 44, fig. 19. Upper Silurian, Missouri.

——— *tributa* Dunn, **35,** p. 334, pl. 43, fig. 26. Upper Silurian, Missouri.

Thurammina ? hexactinellida Dunn, **35,** p. 332, pl. 43, figs. 19 and 36. Middle Silurian, Illinois.

——— *? seminaformis* Dunn, **35,** p. 333, pl. 44, figs. 2–5. Lower Silurian, Illinois and Missouri.

Tolypammina tortuosa Dunn, **35,** p. 341, pl. 44, figs. 19–21, and 32. Upper Silurian, Missouri.

Trifarina herberti Cushman and Renz, **27,** p. 9, pl. 2, figs. 11, 12. Eocene, Soldado Rock, Trinidad.

Triticites burgessae Burma, **10,** p. 744, pl. 98, figs. 2 and 13; species 7, text figs. 5–13. Pennsylvanian, Iowa.

——— *caccus* Burma, **10,** p. 744, pl. 98, figs. 4, 5; species 1, text figs. 5–13. Pennsylvanian, Kansas.

——— *callosus* Dunbar and Henbest, **34,** p. 136, pl. 21, fig. 15; pl. 22, figs. 1–11. Pennsylvanian (Greenup limestone), Illinois.

——— *collus* Burma, **10,** p. 744, pl. 98, figs. 9 and 14; species 3, text figs. 5–13. Pennsylvanian, Iowa.

——— *mediocris* Dunbar and Henbest, **34,** p. 134, pl. 21, figs. 2–5, 7, 8, 16. Pennsylvanian (Greenup limestone), Illinois.

——— ——— ——— var. *angustus* Dunbar and Henbest, **34,** p. 135, pl. 21, figs. 1, 6, 9–14. Pennsylvanian (Greenup limestone). Illinois.

——— *newelli* Burma, **10,** p. 749, pl. 98, figs. 7 and 10; species 5, text figs. 5–13. Pennsylvanian, Kansas.

——— *pauper* Dunbar and Henbest, **34,** p. 139, pl. 23, figs. 1–5. Pennsylvanian (Shumway limestone), Illinois.

——— *turgidus* Dunbar and Henbest, **34,** p. 138, pl. 23, figs. 6–12. Pennsylvanian (Shumway limestone), Illinois.

——— *venustus* Dunbar and Henbest, **34,** p. 132,

pl. 20, figs. 5–19. Pennsylvanian (Omega limestone), Illinois.

Turritellella fisheri Dunn, **35,** p. 340, pl. 44, fig. 30. Upper Silurian, Illinois.

——— *osgoodensis* Dunn, **35,** p. 341, pl. 44, fig. 22. Upper Silurian, Illinois.

——— *workmani* Dunn, **35,** p. 341, pl. 44, fig. 31. Upper Silurian, Illinois.

Uvigerina buricensis Coryell and Mossman, **15,** p. 244, pl. 36, fig. 51. Pliocene, Panama.

——— *gallowayi* Coryell and Mossman, **15,** p. 244, pl. 36, fig. 50. Pliocene, Panama. (Note: This species name is preoccupied by Cushman, 1929, Cushman Lab. Foram. Res., Contr., vol. 5, p. 94, pl. 13, figs. 33, 34, for a form in the Ecuadorian Oligocene.)

——— *striata* d'Orbigny, 1839, var. *attenuata* Coryell and Mossman, **15,** p. 245, pl. 36, fig. 55. Pliocene, Panama. (Note: This varietal name is preoccupied by *Uvigerina auberiana* d'Orbigny, 1839, var. *attenuata* Cushman and Renz, 1941, Cushman Lab. Foram. Research, Contr., vol. 17, p. 21, pl. 3, fig. 17 from the Venzeuelan Miocene.)

Vaginulina midwayana Fox and Ross, **37,** p. 669, footnote 5. Paleocene, Midway, Texas. For: *Vaginulina robusta* Plummer, 1926, (non *Vaginulina truncata* Reuss, 1863, var. *robusta* Chapman and Berthelin, 1894: non *Vaginulina robusta* Galloway and Wissler, 1927) Univ. Texas Bull. 2644, p. 112, pl. 6, fig. 4; pl. 13, fig. 3.

——— *texana* Cushman, 1930, var. *suturocostata* Cushman and Deaderick, **24,** p. 59, pl. 12, figs. 7–10. Upper Cretaceous, Arkansas. For: *Vaginulina simondsi* Cushman, 1930, (non Carsey, 1926), Cushman Lab. Foram. Research, Contr., vol. 6, p. 27, pl. 4, figs. 6–8.

Valvulineria johnsoni Coryell and Mossman, **15,** p. 235, pl. 36, figs. 10–12. Pliocene, Panama.

——— *scintillans* Coryell and Mossman, **15,** p. 236, pl. 36, figs. 13–15. Pliocene, Panama.

——— ——— ——— ——— var. *sinecarina* Coryell and Mossman, **15,** p. 236, pl. 36, figs. 16–18. Pliocene, Panama.

WAERINGELLA gen. nov., Thompson, **106,** p. 413. Fam. Fusulinidae. Genotype: *Waeringella spiveyi* Thompson, 1942, ut infra. Upper Pennsylvanian.

——— *spiveyi* Thompson, **106,** p. 414, pl. 2, figs. 1–15. Upper Pennsylvanian, Texas.

Wedekindellina ellipsoides Dunbar and Henbest, **34,** p. 101, pl. 9, figs. 9–14. Pennsylvanian, Illinois.

Yabeina minuta Thompson and Wheeler, **110,** p. 707, pl. 106, figs. 6–9, ?10. Permian, British Columbia.

——— *packardi* Thompson and Wheeler, **110,** p. 710, pl. 106, fig. 4; pl. 107, figs. 2–4; pl. 108, fig. 4. Permian, Oregon.

FORMS WITH NOMENCLATURA APERTA

Allomorphina n. sp. Fox and Ross, **37,** p. 670, footnote 6. Paleocene, Midway, North Dakota. For: *Allomorphina trigona* Plummer, 1926, (non Reuss, 1850), Univ. Texas Bull., 2644, p. 129, pl. 8, fig. 5.

Ammodiscus sp. Cushman and Siegfus, **28,** p. 401, pl. 15, fig. 4. Eocene, California.

Ammomarginulina sp. Cushman and Renz, **27,** p. 3, pl. 1, fig. 1. Eocene, Trinidad.

Anomalina sp. Cole, **12,** p. 35, pl. 2, figs. 9, 10. Upper Cretaceous, Florida.

——— *sp.* Cushman and Renz, **27,** p. 13, pl. 3, fig. 8. Eocene, Trinidad.

——— *sp.* Cushman and Todd, **30,** p. 345, pl. 8, figs. 11, 12. Eocene, Alabama.

Bolivina sp. Cushman and Todd, **30,** p. 37, pl. 6, fig. 25. Eocene, Alabama.

——— *sp.* Cushman and Todd, **30,** p. 37, pl. 6, fig. 26. Eocene, Alabama.

Buliminella sp. Bergquist, **5,** p. 65, pl. 7, figs. 1–6. Eocene, Mississippi.

Cancris sp. Cushman and Todd, **31,** p. 90, pl. 23, figs. 3, 4. Upper Eocene, Gulf Coast USA. For: *Cancris brongniartii* Cushman, 1935 (non d'Orbigny, 1826), U. S. Geol. Surv., Prof. Pap. 181, p. 48, pl. 20, fig. 1.

——— *sp.* Cushman and Todd, **31,** p. 90, pl. 23, fig. 5. Miocene, California. For: *Cancris sagra* Cushman and Laiming, 1931 (non d'Orbigny, 1839), Jour. Paleontology, vol. 5, p. 115, pl. 14, fig. 3.

Cibicidella sp. Bergquist, **5,** p. 103, pl. 10, fig. 19. Upper Eocene, Mississippi.

Clavulinoides sp. Cushman and Siegfus, **28,** p. 402, pl. 19, figs. 1–3. Eocene, California.

Coleites n. sp. Brotzen, **8,** p. 36, text fig. 12, No. 10. Danian, Sweden.

Dentalina sp. Cushman and McGlamery, **26,** p. 67, pl. 4, figs. 11, 12. Oligocene, Alabama.

——— *sp.* Cushman and Todd, **30,** p. 30, pl. 5, fig. 19. Eocene, Alabama.

——— *sp.* Cushman and Todd, **30,** p. 30, pl. 5, figs. 16, 20, 23, 24. Eocene, Alabama.

——— *sp.* (*A*) Bergquist, **5,** p. 45, pl. 4, figs. 18, 27, 29. Eocene, Mississippi.

Dentalina ? sp. Cushman and Siegfus, **28,** p. 405, pl. 16, figs, 1, 2. Eocene, California.

——— *? sp.* Cushman and Siegfus, **28,** p. 405, pl. 16, figs, 3, 4. Eocene, California.

——— *? sp.* Cushman and Siegfus, **28,** p. 406, pl. 16, fig. 5. Eocene, California.

——— *? sp.* Cushman and Siegfus, **28,** p. 406, pl. 16, fig. 6. Eocene, California.

——— *? sp.* Cushman and Siegfus, **28,** p. 406, pl. 16, fig. 8. Eocene, California.

——— *? sp.* Cushman and Siegfus, **28,** p. 406, pl. 16, fig. 9. Eocene, California.

——— *? sp.* Cushman and Siegfus, **28,** p. 406, pl. 16, figs. 10, 11. Eocene, California.

Discorbis (?) sp. Cushman and Todd, **30,** p. 38, pl. 7, fig. 4. Eocene, Alabama. (Note: Bandy, Jour. Paleontology, vol. 18, 1944, p. 376, regards this species as belonging to *Globigerina quadripartita* Koch, 1926.)

Dorothia ? sp. Cushman and Siegfus, **28,** p. 402, pl. 19, figs. 4–6. Eocene, California.

Ellipsoglandulina sp. Cushman and Siegfus, **28,** p. 418, pl. 17, fig. 29. Eocene, California.

Ellipsolagena sp. Bergquist, **5,** p. 83, pl. 7, fig. 12. Upper Eocene, Mississippi.

Ellipsonodosaria sp. Cushman and Renz, **27,** p. 10, pl. 2, fig. 3. Eocene, Trinidad.

Ellipsonodosaria ? sp. Cushman and MacGlamery, **26,** p. 72, pl. 6, figs. 13, 14. Oligocene, Alabama.

Ellipsonodosaria sp. A Cushman and Siegfus, **28,** p. 417, pl. 17, figs. 15–18. Eocene, California.

——— *sp. B* Cushman and Siegfus, **28,** p. 417, pl. 17, figs. 19–23. Eocene, California.

——— *sp. C* Cushman and Siegfus, **28,** p. 418, pl. 17, figs. 24–28. Eocene, California.

Fusulina sp. A Dunbar and Henbest, **34,** p. 111, pl. 6, fig. 11. Pennsylvanian, Illinois. For: *Fusulinella n. sp.* Henbest, 1928, Jour. Paleontology, vol. 2, p. 79, pl. 10, figs. 2 and 4.

Globorotalites n. sp. Brotzen, **8,** p. 31. Upper Cretaceous, Texas. For: *Eponides micheliniana* Plummer, 1931 (non d'Orbigny, 1840, *Rotalina*), Univ. Texas Bull. 3101, p. 192, pl. 14, fig. 11; and for: *Truncatulina refulgens* (Montfort, 1808) var. *conica* Carsey, 1926, Univ. Texas Bull. 2612, p. 46, pl. 4, fig. 15.

Guttulina sp. Cushman and Renz, **27,** p. 6, pl. 2, fig. 3. Eocene, Trinidad.

Gyroidina sp. Berquist, **5,** p. 86, pl. 8, fig. 26. Upper Eocene, Mississippi.

——— *sp.* Cushman and McGlamery, **26,** p.73, pl. 6, fig. 20. Oligocene, Alabama.

Haplophragmoides sp. Cushman and Deaderick, **24,,** p. 51, pl. 9, figs. 7, 8. Upper Cretaceous, Arkansas.

Lagena sp. Bergquist, **5,** p. 53, pl. 5, fig. 28. Upper Eocene, Mississippi.

Lenticulina sp. Bergquist, **5,** p. 33, pl. 3, fig. 5. Upper Eocene, Mississippi.

Loxostoma sp. Cushman and McGlamery, **26,** p. 71, pl. 6, figs. 1, 2. Oligocene, Alabama.

Marginulina sp. Bergquist, **5,** p. 40, pl, 4. fig. 7. Upper Eocene, Mississippi.

——— *sp.* Cushman and McGlamery, **26,** p. 67, pl. 4, figs. 6, 7. Oligocene, Alabama.

Marginulina ? sp. Cushman and Siegfus, **28,** p. 409, pl. 16, fig. 22. Eocene, California.

Nankinella (?) sp. Thompson and Wheeler, **110,** p. 705, pl. 106, figs. 1–3. Permian, British Columbia.

Nodogenerina ? sp. Cushman and McGlamery, **26,** p. 69, pl. 5, fig. 13. Oligocene, Alabama.

——— *? sp.* Cushman and Siegfus, **28,** p. 411, pl. 16, fig. 36. Eocene, California.

Nodosaria sp. Cushman and Todd, **30,** p. 31, pl. 5, fig. 26. Eocene, Alabama.

Nodosaria ? sp. Cushman and Siegfus, **28,** p. 407, pl. 16, fig. 23. Eocene, California.

——— *? sp.* Cushman and Siegfus, **28,** p. 408, pl. 19, fig. 12. Eocene, California.

Patellinoides sp. Cushman and Todd, **30,** p. 38, pl. 7, fig. 3. Eocene, Alabama.

Planularia sp. Cushman and Todd, **30,** p. 27, pl. 5, fig. 8. Eocene, Alabama.

Plectofrondicularia sp. Cushman and Siegfus, **28,** p. 410, pl. 16, fig. 30. Eocene, California.

Pleurostomella sp. Cushman and Siegfus, **28,** p. 415, pl. 17, fig. 7. Eocene, California.

Pseudopolymorphina sp. Cushman and Renz, **27,** p. 7, pl. 2, fig. 6. Eocene, Trinidad.

Quinqueloculina sp. Bergquist, **5,** p. 21, pl. 2, fig. 23. Eocene, Mississippi.

——— *sp.* Cushman and McGlamery, **26,** p. 66, pl. 4, fig. 2. Oligocene, Alabama.

——— *sp.* Cushman and Renz, **27,** p. 4, pl. 1, fig. 3. Eocene, Trinidad.

Reophax sp. Garrett, **39,** p. 461, pl. 70, fig. 7. Miocene, Texas.

Robulus sp. Cushman and Renz, **27,** p. 5, pl. 1, fig. 5. Eocene, Trinidad.

——— *sp.* Cushman and Siegfus, **28,** p. 405, pl. 15, fig. 25. Eocene, California.

Sigmoilina ? sp. Cushman and Siegfus, **28,** p. 404, pl. 15, fig. 18. Eocene, California.

Siphonodosaria (?) sp. Cushman, **19,** p. 61, pl. 15, fig. 14. Recent, Tropical Pacific.

Spirillina sp. Cushman and Renz, **27,** p. 10, pl. 2, figs. 14, 15. Eocene, Trinidad.

Spiroloculina ? sp. Cushman and Siegfus, **28,** p. 404, pl. 15, figs. 15–17. Eocene, California.

Textularia sp. Bergquist, **5,** p. 17, pl. 1, fig. 17, Upper Eocene, Mississippi.

Triloculina sp. Bergquist, **5,** p. 25, pl. 2, fig. 17. Upper Eocene, Mississippi.

Uvigerina sp. Berquist, **5,** p. 80, pl. 8, fig. 10. Upper Eocene, Mississippi.

Vaginulina sp. Bergquist, **5,** p. 48, pl. 5, fig. 16. Upper Eocene, Mississippi.

——— *sp.* Cushman and McGlamery, **26,** p. 67, pl. 4, fig. 21. Oligocene, Alabama.

NOMINA NUDA

In the foraminiferal literature for the year 1942 the following *nomina nuda* were noted:

Coskinolina adkinsi Barker, **2,** p. 50. Lower Cretaceous of Texas.

Globorotalites n. sp. Brotzen, **8,** p. 31. Turonian of Bohemia.

Globorotalites n. sp. Brotzen, **8,** p. 31. Campanian of Sweden.

HANTKENINELLA nom. nud. Thalmann, **96,** p. 817, table II, fifth column.

Saracenaria mackini Beck, **4,** p. 49. Eocene of Washington, U.S.A.

None of the above-mentioned *nomina nuda* is accompanied by description, illustration or reference.

SUPPLEMENT TO INDEX FOR 1939

The publication by Myatliuk, **121,** unavailable to the author, is said to contain many new species of Foraminifera from Jurassic beds of the Jenissei-Lena region of Asiatic U.S.S.R.

SUPPLEMENT TO INDEX FOR 1940

The following species and variety should be added to the Index for 1940:

Planularia cushmani Palmer, 1940, var. *ornata* Palmer, 1940, Soc. Cubana Hist. Nat., Mem., vol. 14, p. 132, pl. 18, fig. 8. Upper Oligocene (Cojimar), Cuba. (Note: According to Ellis and Messina, Catalogue of Foraminifera, the varietal name is preoccupied by *Cristellaria* (*Planularia*) *ornata* Terquem, 1858.)

Triloculina bermudezi Acosta, **123,** p. 37, pl. 4, figs. 1–5. Recent, off Isla Anguila, Bahamas, depth 15 meters.

SUPPLEMENT TO INDEX FOR 1941

The following list of new forms should be added to the Index for the year 1941. Because of the fact that the publications were unavailable in Ecuador I was unable to canvass their contents as to exact citation of page, plate, figure, and age of these new forms:

BISERIAMMINA gen. nov. Chernysheva, **131,** a new genus from the Lower Carboniferous of the Urals regions, U.S.S.R., with genotype:

——— *uralica* Chernysheva, **131,** pp. 69–70, text figs. 1–3. Lower Carboniferous, Tournaisian, Urals.

CHUARIA gen. nov. Brotzen, **129,** a new genus for a chitinous foraminifer from the pre-Cambrian Visingsö formation of Sweden. Genotype:

——— *wimani* Brotzen, **129,** described and figured on pp. 245 to 261.

Darbyella nitida ten Dam and Reinhold, **133,** p. 110, pl. 1, fig. 2; pl. 2, fig. 1. Middle Oligocene, Winterswijk, Holland.

Fusulina innae Rozovskaya, **145,** pp. 190–192, 2 text figs., from Middle Carboniferous beds of the Moscow region, U.S.S.R.

MANUSCRIPT RECEIVED FEBRUARY 21, 1945.

JOURNAL OF PALEONTOLOGY, VOL. 19, NO. 4, P. 411, JULY 1945

PALEONTOLOGICAL NOTES

BICORBIS ARIZONICA CONDRA AND ELIAS, NEW NAME FOR B. ARIZONICA

Doctor H. B. Stenzel kindly calls our attention to the fact that the generic name *Bicorbula* is preoccupied (by P. Fisher, Manuel de Conchyologie, p. 1123, Paris, 1887). Consequently we introduce a new generic name *Bicorbis*, preserving the meaning: double basket, *corbula* being diminutive of *corbis*. The specific name of the fossil becomes *Bicorbis arizonica* Condra and Elias.

G. E. Condra and and M. K. Elias

CYTHEREIS PIPKINENSIS STEPHENSON, NEW NAME FOR C. HANNAI

Dr. Horace N. Coryell has called attention to a homonym in my recent paper in this JOURNAL, in which I described a group of Ostracoda from subsurface beds of middle Tertiary age from Jefferson County, Texas. In this study, a new species was designated as *Cythereis hannai* Stephenson (Stephenson, M. B., 1944, JOUR. PALEONTOLOGY, vol. 18, p. 157, pl. 28, figs. 11, 12). This name is invalid because of the form described as *C. hannai* Israelsky (Israelsky, M. C., 1929, Arkansas Geol. Survey, Bull. 2, p. 16, pl. IV A, figs. 1a–c) from the upper Cretaceous of Arkansas. The new name *Cythereis pipkinensis* Stephenson is here proposed for the homonym *C. hannai* Stephenson. My thanks are extended to Dr. Coryell for having pointed out this error.

Morton B. Stephenson

JOURNAL OF PALEONTOLOGY, VOL. 19, NO. 4, PP. 412–415, JULY 1945

REVIEWS

INDEX FOSSILS OF NORTH AMERICA, by Hervey W. Shimer and Robert W. Shrock, John Wiley & Sons. 837 pp. 303 pls. 1944. $20.

This book which bears a name similar to that of the older and well-known work by Grabau and Shimer is an entirely new compilation little resembling its predecessor. It differs principally in that its emphasis is placed on genera rather than on species and its illustrations are grouped in plates facing nearly every other page instead of being inserted individually in the text. Its preparation was begun over five years ago and aid in varying degrees was generously given by many paleontologists whose contributions are scrupulously acknowledged in detail. Most figures are copies of previously published illustrations but many, particularly among the brachiopods, are new photographs of carefully selected specimens or, among the crinoids, highly revealing drawings.

The introductory chapter explains the purpose of the book. "to describe and illustrate as many as possible of those fossils which can be used to identify and date formations and to correctly correlate them from one area and another." It defines the terms index fossil, form species, form genus and discusses the value of fragmentary fossils of unknown affinity. The form and arrangement of data in subsequent chapters are explained. A list of the principal references to generic names and a list of bibliographies and general reference works are given. A key to abbreviations used throughout the work concludes this chapter.

The main part of the volume consists of 10 chapters in which the invertebrate phyla are considered in the following order: II, Protozoa, III, Porifera, IV, Coelenterata, V, Echinodermata, VI, Worms, VII, Conodonts, VIII, Bryozoa, IX, Brachiopoda, X, Mollusca, and XI, Arthropoda. A twelfth chapter entitled Fossil Plants is devoted to the Diatomaceae, Charophyta and calcareous Algae to which is appended a brief section on Miscellaneous Objects of Probable Organic Origin.

An exhaustive index of 117 pages is divided into two parts. In the first, or Index of Genera, specific names are listed beneath the generic names with which they appear in combination; in the second, or Index of Species, this order is reversed.

Each chapter and several chapter subdivisions is begun by a more or less brief morphologic discussion, several have plates or text figures illustrating morphological features and terminology, and all have most useful bibliographies of significant literature in footnotes.

Generic descriptions are identified by center headings giving generic name, author and date. This may be followed by a listing of one or more synonymous names with or without authors and dates. The genotype species is noted in its original designation. Geologic age is indicated in bold face type and may be followed by notation of geographic range.

The generic diagnosis is generally followed by the listing of one or more species with name in bold face, author's name, plate reference (in boldface), age (in boldface) and geographic distribution. Many species are briefly described.

Such data are presented for about 2,400 genera (including a few subgenera) and 4,600 species—not 7,500 species as stated on the jacket. They are distributed geologically about as indicated in the accompanying table which presents the results of a single careful but unchecked count.

The book appears to have been printed by the planograph method. The plates for the most part are faithful and pleasing reproductions but the text lacks that sharpness which is achieved by type.

Index Fossils of North America will fill a need long felt by all teachers and most students of paleontology and will be warmly welcomed by the geologic profession as a whole. It is particularly important because of the treatment and revision of certain groups by well known specialists. Among these are the section on crinoids by R. C. Moore and L. R. Landon. This and their recent Evolution and Classification of Paleozoic Crinoids (Geol. Soc. America, Special Paper 46, 1943) supplement each other. The section on Paleozoic gastropods, largely prepared by J. B. Knight, gives

many important data supplementary to his Paleozoic Gastropod Genotypes (Geol. Soc. America Special Paper 32, 1941) especially with regard to synonymy of genera. Over 40 per cent of 226 out of 436 available generic names included in the earlier work are considered to be synonyms. The section on brachiopods by G. A. Cooper is especially noteworthy and is largely illustrated by new photographs. In comparison, a few other sections such as that on the bryozoa appear to have been slighted.

and thus go beyond the strict limits suggested by the book's title.

No two persons would agree upon an extensive list of index fossils and one should not criticize the inclusion of some genera and species that appear to be of little value from this point of view. Some excellent index fossils, however, have been omittld such as *Brachythyris suborbicularis* of the Burlington and Keokuk, which contrasts with *B. subcardiformis* of the Warsaw, and *Platycrinus penicillus*, which is most useful in separating

TABLE 1. GEOLOGIC DISTRIBUTION OF DESCRIBED GENERA (FIRST FIGURES) AND ILLUSTRATED SPECIES (SECOND FIGURES)

	Protozoa	Porifera	Coelenterata	Echinodermata	Worms	Conodonts	Bryozoa	Brachyopoda	Mullusca	Arthropoda	Plants etc.	Total
Recent	87-1	—	9-0	20-3	3-1	—	29-3	6-3	146-66	25-6	1-0	326-83
Pleistocene	87-4	—	9-0	20-2	3-1	—	29-3	6-0	150-62	24-2	1-0	329-74
Pliocene	88-10	—	9-0	22-4	3-0	—	29-6	6-1	146-78	24-3	1-0	328-102
Miocene	91-28	—	11-2	23-12	3-1	—	30-12	6-1	148-163	26-13	1-0	339-232
Oligocene	89-26	—	12-7	18-3	3-0	—	28-9	4-0	132-41	27-16	1-0	314-102
Eocene	93-35	—	17-19	19-7	5-1	—	34-24	4-1	157–126	31-27	4-3	364–243
Cretaceous	99-72	—	18-24	22-51	5-3	—	20-2	5-5	210-347	28-31	7-5	414-540
Jurassic	42-0	—	11-1	6-6	2-0	—	5-0	2-0	89-47	9-4	4-0	170-58
Triassic	20-0	—	11-7	4-1	2-0	—	3-0	4-4	62-24	6-1	3-0	115-37
Permian	31-15	—	15-13	24-7	2-0	12-0	16-0	41-20	91-52	25-11	3-1	260-119
Pennsylvanian	33-38	6-15	18-16	61-141	3-1	17-7	22-7	41-42	131-173	52-58	4-1	388-499
Mississippian	12-1	4-4	30-16	118-240	4-4	26-27	37-29	60-59	100-58	60-76	3-3	454-517
Devonian	6-3	8-4	70-101	92-92	11-27	24-27	54-34	117-184	133-190	89-87	4-2	608-751
Silurian	5-0	6-4	58-60	85-98	12-24	12-4	58-18	76-63	102-60	74-64	4-2	492-397
Ordovician	4-0	13-15	49-85	56-63	10-30	34-50	52-64	79-108	118-229	96-106	6-2	517-752
Cambrian	4-0	12-15	7-5	2-2	2-2	—	—	29-35	17-38	170-262	8-7	249-366
Pre Cambrian	—	—	—	—	—	—	—	—	—	—	1-1	1-1
Total	153-208	37-55	168-341	339-731	15-93	73-114	135-190	304-516	729-1559	418-768	14-17	2391-4599

In some ways this book is more and in others it is less than its name implies. In the first place emphasis is distinctly generic rather than specific. Many species are listed and illustrated without description and serve only as representatives of their genera and the brief descriptions of many other species are inadequate for their recognition and distinction from close relatives. This is unavoidable in a general work because both genera and species are constantly being split and it is becoming increasingly difficult for anyone but a specialist to make satisfactory specific identifications in many groups of fossils. Species, however, furnish the basis for close correlation and dating of formations and in this respect the book falls below its stated objective.

On the other hand many genera and species are included that are not good guide fossils. Some are common and long ranging, others are rare and a few have been only recently described and are of unknown value. All of these serve "to round out the general picture" as the introduction states

Ste. Genevieve from lower Chester, to mention only three. Some years ago I prepared an illustrated list of 109 supposedly most characteristic and useful Mississippian species of Kentucky (Paleontology of Kentucky, Chapt. 5, Ky. Geol. Surv. Ser. 6 Vol. 36, 1931). If I were to make a similar list today it would undoubtedly be different but that list includes most of the good index species of that system in that region. Of these 109 species only 37 are illustrated in the work under consideration and 3 others are listed without figures. Moreover, stratigraphic data for some of these species are presented with insufficient precision so that their real significance as index species is greatly obscured. For example, *Talarocrinus* is cited as "Miss. (Meramec, Chester)" whereas this genus, except for the equivocal *T. simplex*, is strictly confined to the lower Chester, *Pentremites obesus* is referred simply to the Chester but actually occurs only in the lower part of the Golconda formation, and *Stenoscisma* (=*Camerophoria*) *explanata* is listed as "U. Miss.

(Chester)" although this species is the principal means by which the Middle and upper Chester may be separated from the lower Chester paleontologically.

As might be expected in a work to which so many different persons contributed numerous inconsistencies occur. Some of these such as the indiscriminate and apparently purposeless interchangeable use of boldface type in stratigraphic citations to system, series, group or formation (and the occasional omission of any direct citation) are of small importance but might have been systematized in editing. Somewhat more confusing is the reference of Midway strata to the Paleocene on some pages and to the Eocene on others. Definitely troublesome is the current confusion regarding the possible Devonian or Mississippian age of certain Kinderhook beds and the reference of some species from the Louisiana limestone to the Devonian and others to the Mississippian (see *Hybochilocrinus americanus* and *Schuchertella lens*).

In my opinion the greatest value of this work lies in its plates which probably represent the best and most generally useful collection of fossil illustrations ever gathered between two covers. Unfortunately they are difficult to use. The plate explanations are in small type running completely across the bottom of the wide opposite page, are hard to read and give neither the age of the species nor a page reference to the text. If the related text is not located on the facing page, and it may be ten or more pages distant, one must refer to the index and turn to the text to determine the age of a figured species.

One of the excellent features of this book that is to be highly commended is the citation of the type species of each genus. Here, however, inconsistency also occurs because some are followed by the author's name but others are not. To be most useful both author's name and date of publication should have been appended.

Another feature of great interest to all paleontologists is the reference of many species to little-known genera. In most cases this represents the modern tendency toward more precise discrimination and the indicated opinions of various specialists are most worthwhile. However, the reader without considerable experience will encounter much difficulty in recognizing familiar species which might have been avoided if the older and more familiar combinations of names had also been indicated. For example about one-third of the Kentucky Mississippian species previously mentioned have been referred to genera only recently described or recently discriminated. Likewise numerous species referred for many years to such inclusive genera as *Productus*, and *Pleurotomaria* now find their places under a considerable number of other genera. In fact, neither *Productus* nor *Pleurotomaria* as a genus appears in this work. Surely both exist and some note regarding each of them should have been inserted even though it seemed undesirable to include any of their species. Finally it would have been advantageous to indicate the dates of publication of all species in order to facilitate their location in the literature.

Genera are variously arranged in different chapters or different parts of chapters as mentioned in the introduction. Some are in taxonomic order, some in stratigraphic order and others are presented in alphabetical order. An attempt at taxonomic presentation should have been made throughout even though the imperfections of results were recognized. As it is, many similar or closely related genera are separated and comparison is difficult. Also in the brief generic diagnoses a greater use of comparisons would have been advantageous.

Although I have mentioned a number of obvious shortcomings of Index Fossils of North America I believe that the compilers are to be congratulated on the general excellence of their work. Every paleontologist and most students of paleontology would like to own a copy of this book and its comparatively great publication price is to be regretted.

J. MARVIN WELLER

MIOCENE FORAMINIFERA FROM SUMATRA AND JAVA, NETHERLANDS EAST INDIES, by L. W. LeRoy. Colorado School of Mines Quarterly, vol. 39, no. 3, 113 pp., 15 pl., 2 maps; $2.00. July 1944.

This excellent study is a welcome addition to our limited knowledge of the faunas of the East Indian region. Paleontologists, stratigraphers, and paleoecologists alike will find it worthy of careful study. The present

two papers form a companion volume to three studies previously published by Dr. LeRoy[1] on the late Tertiary of East Borneo, the west coast of Sumatra, and west Java. These reports are accompanied by a large group of fine, clear-cut drawings, the excellent work of Mr. A. Hamid. The plates are rather heavily loaded, but this does not detract from the specific characters of any individual drawing.

The first paper is concerned with the Miocene Foraminifera of central Sumatra. The Telisa formation is subdivided on the basis of fauna and lithology into two facies considered to be time equivalents. The *Globigerinoides* facies, developed in a moderately deep off-shore environment, occurs between the Basal Sandstone Series and the lowest occurrence of *Orbulina universa* d'Orbigny. The *Textularia* facies is indicated to be a "... near-shore, shallow-water, eastward equivalent of the *Globigerinoides* facies." The Lower Palembang formation is transitional between the Telisa and Middle Palembang, the latter formation carrying carbonaceous matter and a fauna believed to be of shallow-water origin. Faunal lists are given for each of these assemblages. The Upper Palembang (Pliocene?) is mainly continental. LeRoy tentatively places the faunas described as lower and middle Miocene in age, and believes them to be more restricted regionally and younger than the *Globorotalia-Pulleniatina-Sphaeroidinella* fauna of the Malay Archipelago. A map and eight plates illustrating the faunas are included. The faunas consist of 183 species, of which 27 species and two varieties are described as new.

The second section deals with the small Foraminifera from the Miocene of West Java. The assemblage described was taken from a single locality on the south coast, and is referred to as the "Tjijarian Bridge faunule." This exotic fauna is believed to be indicative of a warm, shallow-water environment lacking seasonal changes, which gave rise to rapid growth and wide dispersion of genera and species. The material is placed as late Miocene, and slightly older than the *Globorotalia-Pulleniatina-Sphaeroidinella* fauna of the late Tertiary in this area. The assemblage is differentiated from others in the East Indian region by lists of species present in various faunas which are absent from the Tjijarian Bridge faunule. Of the 107 forms included, nine species and one variety are described as new. The families best represented are the Lagenidae, Globigerinidae, Buliminidae, and the Anomalinidae. A map and seven plates of illustrations accompany the report.

Systematic treatment of the species involved reflects a careful study of the literature. The author has apparently been handicapped, however, as so many of us are, in not having access to some of the older publications. Synonymies of a number of species indicate that identifications were made from the works of later authors rather than from original figures and descriptions. This does not detract from the value of the present work, and is the natural outgrowth of the problem of incomplete library facilities with which most authors are faced. The technique of including all available forms in the study is commendable, as is the listing of very rare and doubtful species without specific names. The author appears to have been too conservative in places, as in the four species of *Robulus* (pp. 77, 78) which are fully described and figured, but to which no specific names are given. This constitutes formal description of these species, which will be referred to by later authors only with difficulty. The use of letters to identify such species would have been helpful, as is done in the case of some species included, and some of them probably deserve specific names. Three unfortunate errors in nomenclature were noted: *Rotalia umbonata* LeRoy (p. 35) is a homonym of *R. soldanii* d'Orbigny var. *umbonata* Silvestri.[2] *Globigerina baroemoenensis* var. *quadrata* LeRoy (p. 39) is preoccupied by *G. quadrata* White.[3] *Nodosaria insecta* Schwager var. *spinifera* LeRoy (p. 80) is a homonym of *N. spinifera* Cushman and Campbell.[4]

MORTON B. STEPHENSON

[1] LeRoy, L. W., 1941, Small Foraminifera from the late Tertiary of the Nederlands East Indies: Colorado School of Mines Quarterly, vol. 36, no. 1; $2.00. (Still available.)

[2] Silvestri, A., 1898, Foraminiferi pliocenici della Provincia di Siena: Accad. Pont. Nuovi Lincei, Mem., parte 2, Roma, Italia, vol. 15, p. 329.

[3] White, M. P., 1928, Some index Foraminifera of the Tampico embayment area of Mexico, part 1: Jour. Paleontology, vol. 2, p. 195, pl. 27, fig. 18.

[4] Cushman, J. A. and Campbell, A. S., 1935, Cretaceous Foraminifera from the Moreno shale of California: Contr. Cushman Lab. Foram. Res., vol. 11, pt. 30, p. 71.

JOURNAL OF PALEONTOLOGY, VOL. 19, NO. 4, PP. 416–420, JULY 1945

SOCIETY RECORDS AND ACTIVITIES

REPORTS AND MINUTES OF THE NINETEENTH ANNUAL MEETING OF THE SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS

The nineteenth annual meeting of the Society of Economic Paleontologists and Mineralogists was held in Tulsa, Oklahoma, March 27, 1945. In compliance with the request of the Honorable James F. Byrnes, Director of War Mobilization and Reconversion, the meeting was reduced in scope to comply with this request. Necessary Society business was transacted by Charles R. Ryniker of Tulsa acting as substitute for the members of the Council, who were unable to attend. Other Council business was transacted by mail. All papers submitted were read by title from 3:30 to 3:40 P.M. before an audience consisting of Gayle Scott, Jerry Upp, and Stanley G. Wissler.

The following papers were read by title.

Alfred R. Loeblich, Jr., "Foraminifera from the Type Pepper Shale of Texas."

Charles E. Decker, "Identification and Use of Some Invertebrate Fossils"

M. L. Thompson, "Identification of Fossils—Fusulinids"

W. C. Darrah, "The Application of Paleobotanical Methods to Carbonaceous Sediments"

W. H. Twenhofel, "Review of Progress in Sedimentary Petrology since the Founding of the S.E.P.M. and a Forecast of the Outlook for the Future"

R. W. Harris, "Progress in Stratigraphic Geology in the Mid-Continent Region"

H. V. Howe, "Progress in Stratigraphic Paleontology in the Eastern Gulf Region"

J. H. Johnson, "Progress in Stratigraphic Geology in the Rocky Mountain Region"

K. K. Landes, "Progress in Stratigraphy of the Michigan Basin Region in Recent Years"

F. B. Plummer, "Progress Review of the Carboniferous and Permian of Texas"

Gayle Scott, "Recent Progress in the Study of Mesozoic Stratigraphy in the Texas Area"

M. V. Howard, "Suggestions for a Course in Stratigraphy"

1. *Report of the Editor of the Journal of Paleontology* (J. Marvin Weller).—

Volume 18 of the Journal of Paleontology, issued in conjunction with the Paleontological Society in 1944, contains 565 pages and 93 collotype plates. Published in it are 51 paleontological papers, 1 paper each in the fields of bibliography, paleoecology and technique, 7 notes, 6 reviews, and data relating to the activities and memberships of the two societies.

The March, July and November issues were prepared by your editor in behalf of the Society of Economic Paleontologists and Mineralogists. These numbers consist of 317 pages and 49 collotype plates, an increase of 37 pages and 10 plates over 1943. The contributions in these numbers may be classified as follows:

	Paleozoic	*Mesozoic*	*Cenozoic*
Foraminifera	1	2	5
Ostracods	2		2
Corals	2		1
Bryozoans	2		
Trilobites	2		
Crabs	1	1	1
Graptolites	1		

Three of these papers describe foreign species. Five other papers deal with composition of conodonts, technique, bibliography, nomenclature, Ordovician of Peru, and paleoecology.

The number of papers submitted for publication has fallen off greatly during the last year and the backlog of manuscripts is only about one-third of what it was a year ago. In order to compensate for this trend it will probably be necessary to sharply reduce the size of the issues to be printed in the near future.

2. *Report of the Editor of the Journal of Sedimentary Petrology* (W. H. Twenhofel).—

The customary three numbers of the Journal of Sedimentary Petrology were issued during 1944 with a total of 148 pages together with an index. Thirteen articles, three reviews, and two announcements were published. Six articles dealt with certain phases of the petrology of sedimentary deposits; one with texture and density of sediments; one with errors of sampling for me-

chanical analysis, and one giving results of mechanical analyses; and four other articles dealing with miscellaneous features of sediments.

Contributions of manuscripts have kept ahead of needs except during the past year when there has been a considerable falling off of contributions. This has not added to the comfort of the Editor. Also, manuscripts are contributed by too few members of the Society. It would be an extremely healthy development if every member of the petrologic and sedimentational contingent of the Economic Paleontologists and Mineralogists would endeavor to contribute an article, a review, or a note once every two or three years. The Journal would then become more useful than it now is.

The Journal seems to serve geologists and sedimentationists, and if one notes articles dealing with petrology and sediments in any of its phases one can not fail to be impressed by the number of references that are made to the papers published in the Journal.

3. *Report of the Secretary-Treasurer* (H. B. Stenzel).—

BACK VOLUME SALES

Back volumes of the Journal of Paleontology	$753.20
Back volumes of the Journal of Sedimentary Petrology	$378.50

PRINTING AND ENGRAVING BILLS FOR 1944

Journal of Paleontology

	Banta Printing Bills	*Meriden Engraving Bills*	*Total Printing and Engraving Bills*	*S.E.P.M. Total Printing and Engraving Bills*
Number 1 (January)*	$ 731.96	$ 465.30	$1,197.26	$
Number 2 (March)	880.40	329.13	1,209.53	1,209.53
Number 3 (May)*	534.27	205.92	740.19	
Number 4 (July)	783.22	428.88	1,212.10	1,212.10
Number 5 (September)*	488.38	367.37	855.75	
Number 6 (November)	618.35	355.73	974.08	974.08
	$4,036.58	$2,152.33	$6,188.91	$3,395.71
(1943 Totals)	($4,281.05)	($2,552.20)	(6,833.25)	($3,010.26)

*Odd numbers paid for by Paleontology Society.

Journal of Sedimentary Petrology

Number 1 (April)	$ 265.65
Number 2 (August)	426.09
Number 3 (December)	358.95
	$1,050.69
(1943 Total)	($ 851.31)

MEMBERSHIP, MAILING, AND JOURNAL STATISTICS

	March 1945	*March 1944*	*March 1943*
1. S.E.P.M. Membership:			
Active Members	268	254	251
Associate Members	75	69	66
Total	343	323	317
2. Journal of Paleontology Mailing List:			
S.E.P.M. Active Members	212	203	215
S.E.P.M. Associate Members	49	47	44
S.E.P.M. Subscribers	308	283	255
P.S. Members	332	323	323
Total	901	856	837

3. Journal of Sedimentary Petrology Mailing List:			
S.E.P.M. Active Members	133	116	114
S.E.P.M. Associate Members	25	19	19
S.E.P.M. Subscribers	245	213	213
Total	403	348	346
4. Number of pages in 1944 Journal of Paleontology		565 (641, 1943)	
5. Number of plates in 1944 Journal of Paleontology		93 (109, 1943)	
6. Total edition of 1944 Journal of Paleontology		1300 (1300, 1943)	
7. Number of pages in 1944 Journal of Sedimentary Petrology		148 (130, 1943)	
8. Total edition of 1944 Journal of Sedimentary Petrology		500 (500, 1943)	
New members from March 1, 1944, to March 1, 1945		15 (13, 1943–1944)	
New associates from March 1, 1944, to March 1, 1945		10 (8, 1943–1944)	
Transfers to active membership, March 1, 1944, to March 1, 1945		3 (2, 1943–1944)	

FINANCIAL STATEMENT, DIVISION OF PALEONTOLOGY AND MINERALOGY, FOR THE YEAR 1944

BALANCE SHEET
DECEMBER 31, 1944

ASSETS

CURRENT ASSETS:		
Demand deposits		$ 3,523.83
Savings deposit		2,231.65
Accounts receivable less reserve of		49.14
TOTAL CURRENT ASSETS		$ 5,804.62
PUBLICATIONS:		
24,244 Journals of Paleontology issued prior to 1944 (comprising 4,134 complete volumes) at $.50 per Journal	$12,122.00	
2,291 Journals of Paleontology, issues 1 to 6 of 1944, at cost	1,848.36	
4,526 Journals of Sedimentary Petrology issued prior to 1944 (comprising 1,540 complete volumes) at $.50 per Journal	2,263.00	
323 Journals of Sedimentary Petrology, issues 1, 2 and 3 of 1944, at cost	229.74	16,463.10
FURNITURE AND FIXTURES less reserve of $337.24		145.36
TOTAL ASSETS		$22,413.08

LIABILITIES AND SURPLUS

CURRENT LIABILITIES:		
Accounts payable		$ 883.13
Amount payable to Paleontological Society		525.48
TOTAL CURRENT LIABILITIES		$ 1,408.61
DEFERRED INCOME:		
Subscriptions to Journals	$ 1,906.37	
Membership dues for 1945 and 1946	880.66	2,787.03
SURPLUS:		
Balance, December 31, 1943	$19,097.41	
New *loss* for year ended December 31, 1944 (per statement attached)	*−879.97*	
Balance, December 31, 1944		18,217.44
TOTAL LIABILITIES AND SURPLUS		$22,413.08

STATEMENT OF INCOME FOR YEAR ENDED DECEMBER 31, 1944

INCOME:		
Membership dues and subscriptions—		
Journal of Paleontology and Sedimentary Petrology		$ 784.00
Journal of Paleontology		2,748.20
Journal of Sedimentary Petrology		890.72
		$4,422.92
Sales of back numbers—		
Journal of Paleontology	$ 702.60	
Journal of Sedimentary Petrology	303.60	1,096.20
Sales of plates and reprints		274.15
Advertising		62.46
Miscellaneous		28.24
TOTAL INCOME		$5,883.97
Less: Proportion of income accrued to Paleontological Society		525.48
NET INCOME		$5,358.49
COSTS OF EXPENSES:		
Cost of printing—		
Journal of Paleontology	$3,522.48	
Journal of Sedimentary Petrology	1,052.11	
	$4,574.59	
Clerical salaries	970.00	
Office supplies and expenses	138.05	
Office rent	330.00	
Postage, telegraph and delivery expense	293.67	
Audit fee	100.00	
Insurance and bond	54.85	
Depreciation	48.26	
Provision for bad debts	44.91	
Taxes	35.86	
TOTAL COSTS AND EXPENSES	$6,590.19	
Less: COSTS AND EXPENSES	351.73	6,238.46
NEW LOSS		$−879.97

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

To the Council,
Society of Economic Paleontologists and Mineralogists.

We have examined the balance sheet of SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS at December 31, 1944, and the statement of income for the year then ended, have reviewed the accounting procedures of the Society and, without making a detailed audit of the transactions have examined or tested accounting records of the Society and other supporting evidence, by methods and to the extent we deemed appropriate. Our examination was made in accordance with generally accepted auditing standards applicable in the circumstances and included all procedures which we considered necessary.

In our opinion, the accompanying balance sheet and statement of income present fairly the position of Society of Economic Paleontologists and Mineralogists at December 31, 1944, and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

(Signed) ARTHUR YOUNG & COMPANY, *Accountants and Auditors*

TULSA, OKLAHOMA
January 27, 1945

4. *The following are newly elected officers of the Society.*

John R. Sandidge.....President
J. Brookes Knight.....Vice-President
H. B. Stenzel.....Secretary-Treasurer

OFFICERS OF THE SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS

	President	*Vice-President*	*Secretary-Treasurer*	*Term of Office* (1 Year)
1.	J. J. Galloway	Donald D. Hughes	Marcus A. Hanna	1927–1928
2.	R. C. Moore	G. Dallas Hanna	F. B. Plummer	1928–1929
3.	Marcus A. Hanna	John B. Reeside, Jr.	F. B. Plummer	1929–1930
4.	J. A. Cushman	C. C. Church	Gayle Scott	1930–1931
5.	Charles E. Decker	Walter S. Adkins	Gayle Scott	1931–1932
6.	G. Dallas Hanna	James Waters	Gayle Scott	1932–1933
7.	F. B. Plummer	H. G. Schenck	Gayle Scott	1933–1934
8.	N. L. Thomas	Merle C. Israelsky	Gayle Scott	1934–1935
9.	W. H. Twenhofel	U. S. Grant IV	Gayle Scott	1935–1936
10.	Merle C. Israelsky	R. W. Harris	Gayle Scott	1936–1937
11.	Stanley G. Wissler	F. W. Rolshausen	Henry V. Howe	1937–1938
12.	E. H. Sellards	Paul P. Goudkoff	Henry V. Howe	1938–1939
13.	Gayle Scott	Herschel L. Driver	H. B. Stenzel	1939–1940
14.	Carey Croneis	John R. Sandidge	H. B. Stenzel	1940–1941
15.	Henry V. Howe	Alva C. Ellisor	H. B. Stenzel	1941–1942
16.	Herschel L. Driver	Parker D. Trask	H. B. Stenzel	1942–1943
17.	J. Harlan Johnson	R. Dana Russell	H. B. Stenzel	1943–1944
18.	Donald D. Hughes	Hershal C. Ferguson	H. B. Stenzel	1944–1945
19.	John R. Sandidge	J. Brookes Knight	H. B. Stenzel	1945–1946

ERRATA

The following corrections to my paper on the Foraminifera from the Porters Creek shale (JOURNAL OF PALEONTOLOGY, vol. 18, no. 4)

Page 346, col. 2, line 6 read Textulariidae for Textredariidae.

Page 348, pl. expl. and p. 351 col. 2 near bottom read *Siphogeneroides* for *Siphonogeneroides.*

Page 353, center col. 1, read *Siphonina* for *Siphonia;* col. 2, read d'Orbigny for Bermudez under genus *Anomolina.*

Page 354, references, read Plummer, Helen J. for Helen G.

I wish to thank Mr. M. B. Stephenson for calling these errors to my attention.

CHALMER L. COOPER

OFFICERS OF THE SOCIETIES

THE SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS

For the year ending March 1946

President, JOHN R. SANDIDGE, San Antonio, Tex.

First Past-President, DONALD D. HUGHES, Stanford University, Calif.

Second Past-President, J. HARLAN JOHNSON, Golden, Colo.

Vice-President, J. BROOKES KNIGHT, Princeton, N. J.

Secretary-Treasurer, H. B. STENZEL, Austin, Tex.

Editor, J. MARVIN WELLER, Urbana, Ill.

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

For the year ending March 1946

President, M. G. CHENEY, Coleman, Tex.

Past-President, IRA H. CRAM, Chicago, Ill.

Vice-President, M. GORDON GULLEY, Pittsburgh, Pa.

Secretary-Treasurer, EDWARD A. KOESTER, Wichita, Kan.

Editor, GAYLE SCOTT, Fort Worth, Tex.

THE PALEONTOLOGICAL SOCIETY

For the year ending December 1945

President, CHESTER STOCK, Pasadena, Calif.
Vice-President, MARSHALL KAY, New York, N. Y.
Secretary, H. E. VOKES, Washington, D.C.
Treasurer, R. R. SHROCK, Cambridge, Mass.; C. O. DUNBAR (acting), New Haven, Conn.
Editor, C. WYTHE COOKE, Washington, D.C.
Chairman, Cordilleran Section, W. P. POPENOE, Pasadena, Calif.

Ex-Presidents

E. H. SELLARDS, Austin, Texas, 1942.
JOHN B. REESIDE, JR., Washington, D.C., 1943.
B. F. HOWELL, Princeton, N. J., 1944.

THE GEOLOGICAL SOCIETY OF AMERICA

For the year ending December 1945

President, E. W. BERRY, Baltimore, Md.
Past-President, ADOLPH KNOPF, New Haven, Conn.

Vice-Presidents

N. L. BOWEN, Chicago, Ill.
D. F. HEWETT, Washington, D. C.
B. F. HOWELL, Princeton, N. J.
R. C. EMMONS, Madison, Wis.

Secretary, H. R. ALDRICH, New York, N.Y.

Treasurer, W. O. HOTCHKISS, Troy, N. Y.

Councillors

JAMES GILLULY F. J. ALCOCK K. C. HEALD	1943–1945
T. M. BRODERICK W. H. BRADLEY CHESTER STOCK	1944–1946
JOHN E. ADAMS A. C. WATERS W. P. WOODRING	1945–1947